HARVARD UNIVERSITY

BUSSEY INSTITUTION OF APPLIED BIOLOGY

CONTRIBUTIONS

FROM THE

LABORATORY OF ENTOMOLOGY

VOL. III.

BOSTON
1913–1916

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A Solitary Wasp (*Aphilanthops Frigidus* F. Smith) that Provisions its Nest with Queen Ants

By WILLIAM MORTON WHEELER

Reprinted from THE JOURNAL OF ANIMAL BEHAVIOR
September-October, 1913, vol. 3, no. 5, pp. 374-387

A SOLITARY WASP (*APHILANTHOPS FRIGIDUS* F. SMITH) THAT PROVISIONS ITS NEST WITH QUEEN ANTS[1]

WILLIAM MORTON WHEELER

Several years ago a correspondent sent me a few specimens of a beautiful black and yellow wasp, *Aphilanthops frigidus* F. Smith, each mounted on a pin with a winged queen of the typical *Formica fusca* L. These specimens were collected August 21, 1903, at Silver Creek, Baraga County, in northern Michigan, by Mr. Morgan Hebard. Although it seemed very probable that the ants had been taken as the prey of the wasps, I was not sure of this fact till the past summer, when I was able to study the habits of these insects in the neighborhood of Boston. During this season, in fact, they seem to have been so abundant as to have attracted the attention of other entomologists in New England and Canada.

The nearctic genus *Aphilanthops* was first separated from the closely related *Philanthus* by Patton in 1880 and based on *Ph. frigidus* F. Smith as the type. Since that time Cresson (1865), Fox (1894), Baker (1895), Cockerell (1895, 1896) and Dunning (1896, 1898) have described a number of additional species. Eleven of these altogether are enumerated by Dunning in his monograph of the genus (1898), all confined to the western states, except the type *A. frigidus*. This was originally described from Nova Scotia, but is now known to range over Ontario and New England, as far west as Illinois and Chicago and as far south as New Jersey. Two other species from Mexico have been referred to the genus *Aphilanthops* by Cameron, but Cockerell believes that they really belong to the genus *Eucerceris*.

Concerning the habits of *Aphilanthops* nothing has been published, except the following observations by Ainslee (1909) on *A. taurulus* Ckll.: "Early in August, 1908, while marooned at

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 71.

Albuquerque, New Mexico, waiting for delayed mail, I noticed one day beside a concrete walk that bordered a vacant lot in that city a throng of large red ants which resembled *Pogonomyrmex occidentalis*. The bunch was seething with excitement, and stragglers were continually coming and going. As I watched I noticed a small quadrate-headed wasp drop from the upper air to the hard-trodden soil, alighting without previous reconnoitering. She stood perfectly motionless, not even dressing herself after the manner of her kind when idle. Presently an ant hurried by, busy about nothing, as usual, when instantly the wasp gave chase. The ant dodged and doubled as it fled, but the wasp overtook and seized it after a very brief and intensely active resistance, for a *Pogonomyrmex* is by no means a helpless infant in a skirmish. The wasp and its riotous victim rose heavily into the air and ascended at a sharp angle of flight, until they were lost in the blue of the sky. During the next few minutes I saw the same performance repeated again and again, with variations, until dozens of the ants had disappeared heavenward with the predatory wasps.

"So intent were the wasps on this work that they seemed not in the least disturbed by my presence, and I managed to secure a number of both wasps and ants by taking quick advantage of the struggle always incident to the moment of capture.

"Occasionally an ant, when pursued, would dodge around a blade of grass or rush beneath some welcome shelter and elude its hunter, but this happened in only a few cases. So swift and certain were the motions of the wasps that even with a vantage of six inches or more an ant once followed was almost certainly doomed. The wasps never, so far as I observed, assisted themselves with their wings to gain speed, but played fair with their victims and ran them down. The struggle generally lasted a second or two on the ground, and, as I have said, appeared to be continued fiercely in the air, judging from the frenzied actions of the two as they rose aloft." Ainslee mentions another, possibly undescribed species of *Aphilanthops* which he took at the same time preying on the same ants. Specimens of these, sent me for identification, proved to belong to the large, coarsely sculptured form of agricultural ant, *Pogonomyrmex barbatus* F. Smith subsp. *rugosus* Emery, which makes extensive clearings in the deserts of New Mexico and Arizona. Although not ex-

pressly stated, it is clear from Ainslee's vivid description, that *A. taurulus* preys on the workers of the *Pogonomyrmex*. As will be seen from the following account, our eastern *A. frigidus*, though it also provisions its nests with ants, selects only the fertile females, or queens.

My observations on *frigidus* were made in the Blue Hills, near Boston, during July and August. The wasps were found to be at the height of their activities from July 26 to August 16. By the end of the latter month all the wasps had disappeared and the nests had been effaced by recent heavy showers. Like the species of *Bembex*, *frigidus* nests in colonies. Several of these were located, but observations were confined to three, which happened to be within easy reach from Boston. They were situated in the ravine that separates Great Blue Hill from the adjacent portion of the range, two of them being in the stony and sandy trail passing through Wild Cat Notch, the other on Administration Road. Each colony covered several square yards of territory and comprised from about 30 to 60 nests, the entrances of which were often within an inch or two of one another. In two of the colonies the nests were interspersed with the burrows of large Crabronid wasps and of Cicindelid larvæ. The wasps prefer to make their burrows on slightly sloping surfaces. The opening, a little more than a quarter of an inch in diameter, is semi-circular and lies in front of a little pile of earth that has been thrown out by the burrowing insect. The wasp spends much time, especially during the morning hours or on cloudy days, sitting in her burrow and looking out with her conspicuous black face, marked with three vertical yellow bands like exclamation points. As the heat of the day increases, however, she becomes more active and either does more or less excavating in the nest, kicking the earth out backwards from the entrance to a distance of a few inches, or goes off foraging for her prey. In all of this behavior she exhibits a striking resemblance to *Bembex*.

The burrow descends obliquely and abruptly to a depth of only six to eight inches, where it terminates in a small cell. There are also two or three other cells, but it was found impossible to determine their precise relations to the other portions of the nest, owing to the very dry and crumbling condition of the soil and to the fact that each cell is closed off from the main

burrow. A slender twig or grass culm carefully introduced into the opening of the nest as a probe was invariably stopped a few inches below the surface by an earthen plug or partition which has to be removed by the wasp whenever she enters the deeper portions of the nest.

The prey of *A. frigidus* consists exclusively of winged queen ants belonging to the genus *Formica*. Specimens wrested from the wasps while being brought in and also dug from the nests, belonged to the following four forms:

Formica fusca L. var. *subsericea* Say.

F. fusca L. (typical).

F. (*Neoformica*) *pallidefulva* Latr. subsp. *nitidiventris* Emery.

F. (*Proformica*) *neogagates* Emery.

Most of the specimens belonged to *subsericea*, very few to *neogagates*, while the true *fusca* was more abundantly represented than *nitidiventris*. The nature of the prey, however, depends on the situation of the *Aphilanthops* colony. Thus the prey in the Administration Road colony, which was situated very near the northern side of Great Blue Hill, consisted almost exclusively of the typical *fusca*, which is the only form of the species on this more boreal slope, whereas the more xerothermic *subsericea* and *nitidiventris* were the only forms found in the colony situated on the southern slope. As these two colonies were less than a mile apart, it is clear that the wasps do not range very far in search of their prey. The same wasp may collect queens of two or even three of the four *Formicæ* enumerated above. The pronounced preference for the queens of *fusca* and its variety *subsericea* is shown also in other portions of the geographical range of *A. frigidus*. I have already stated that the specimens of this wasp taken by Hebard in northern Michigan had been preying on *fusca*. Recently while I was visiting my friend Dr. C. Gordon Hewitt at Ottawa, Ontario, the noted melittologist, Mr. Sladen, showed me a specimen of the wasp taken August 12, 1913, with a winged queen of the typical *fusca*. He pointed out to me the site of the colony where he had seen this and other specimens of the wasps carrying in their prey, in the midst of a cultivated plot on the Central Experimental Farm, but all traces of the nests had disappeared at the time of my visit (September 2). During August, Mr. C. W. Johnson brought me a specimen of *frigidus* mounted on

a pin with a winged female of *subsericea*, which he had taken July 31 at Westport Factory, Mass., where he had found a large colony of the wasps nesting in a pebbly wood-road. They were bringing in the *subsericea* queens in great numbers and, curiously enough, were themselves being captured and destroyed by large robber-flies (*Deromyia umbrina*).

The queens of the four *Formicæ* enumerated above, differ considerably from one another, those of *subsericea* being much larger than any of the others and those of *nitidiventris* differing greatly in color, as they have the head and thorax red instead of black. The queens of the true *fusca* and *neogagates* are much alike in size and in being very smooth and shining, but the latter species is readily distinguished by the red color of the legs and the erect hairs on the lower surface of the head. It is significant that all these queens belong to species noted for their cowardly disposition, and as the normal hosts of the slave-making ants (*Polyergus lucidus* Mayr and the various subspecies of *Formica sanguinea* Latr.) and of a long series of temporary social parasites (the various subspecies of *F. rufa* L., *truncicola* Nyl., *exsectoides* Forel, etc.). Although nearly all of these predatory and parasitic ants are abundant in the Blue Hills, none of their queens is captured by the *Aphilanthops*. We must assume, therefore, that this wasp has learned to discriminate between different species of *Formica* and to avoid the more vigorous and aggressive queens of the *sanguinea*, *rufa* and *exsecta* groups. The queens of the *microgyna* group, represented in the Blue Hills by *F. difficilis* Emery, are in all probability avoided on account of their diminutive stature.

That the wasps capture the *Formica* queens while they are celebrating their nuptial flight and do not take them from their nests, was clear from observations made July 26, for on that day flights of *subsericea* and *sanguinea* subsp. *rubicunda* Emery were observed in the Blue Hills and the wasps were seen bringing in numbers of the queens of the former variety. Still I did not see the wasps in the act of capturing their prey till August 15, when there was a great flight from all the colonies of *subsericea* in Forest Hills and Jamaica Plain, Boston. While walking along the street I saw an *Aphilanthops* suddenly swoop down onto a queen that had just settled on the ground. Before I could reach the spot the ant had been stung and the wasp

was dragging her along by the antennæ and trying to rise with her into the air.

The queen ants attract the attention of the wasps only during the few hours that intervene between the nuptial flight and the loss of their wings. On several occasions I saw deälated queens crossing the roads near the wasp colonies or even running near their nest entrances without being noticed by the wasps that were flying about. And on one occasion when I confined a deälated *subsericea* queen in a bottle with an *Aphilanthops*, the ant was still uninjured more than 24 hours later. It is probable, therefore, that the wasp responds only to the visual stimulus of the winged queen, which is, of course, very different from that of the same insect with her wings removed.

The ants are merely stung and paralyzed. The wasp does not mutilate or malaxate her victims, which still move their palpi, legs and antennæ either spontaneously or when touched, for several hours or even for a few days after they have been captured and placed in the nest. In the course of a few days and often sooner, however, all signs of movement have ceased, although the insects still have a fresh appearance, with flexible limbs and without any indications of the drying up of the tissues.

The wasp carries the ant under her body, supporting it by means of her middle and hind legs, while she holds its antennæ in her mandibles. Sometimes when she happens to settle for a moment on a slanting leaf-blade and is therefore obliged to stand on her legs, one may see the ant dangle for a moment from her jaws. On reaching the nest she may begin to enlarge the entrance by digging, still holding the ant by its antennæ and kicking the earth backward around it with her hind legs. Sometimes she may go directly into the nest without any preliminary digging and without dropping her prey. Occasionally, however, she may be seen to drop it just at the entrance, then go into the burrow, turn around and pull the ant in after her by one of its antennæ. This method of getting the ant into the nest is sometimes very awkwardly executed. Once I saw a wasp seize her ant by the petiole and with much effort pull it in doubled on itself. While the wasp is taking the ant into the burrow, she may be closely watched by two parasites, a beautiful metallic green *Chrysis*, or cuckoo-wasp, and a small gray Tachinid fly. I have not seen either of these insects oviposit

on the wasp's prey, nor have I found their larvæ in the nests. The wasp usually introduces her prey into the burrow so expeditiously and then buries it so completely that these parasites must encounter great difficulties in gaining access to it.

After the ant has been dragged a few inches down the burrow, the wasp proceeds to cut off its wings. Usually she does this very neatly, although the stubs she leaves attached to the body are a little longer than they are in queen ants that have deälated themselves. More rarely the wasp simply gnaws off the tips or apical halves of the wings. That this deälation is accomplished before the ant is carried to the lower portion of the nest is shown by the fact that while excavating the nest one always finds the detached wings only a few inches below the surface and some distance from the bodies of the stored ants.

Although I excavated a considerable number of nests with the aid of Messrs. W. M. Mann and F. X. Williams, I have had some difficulty is ascertaining the precise method employed by the *Aphilanthops* in rearing its young. By piecing together the observations made on different nests I have reached the conviction that the wasp secures several queen ants, usually five to seven, often belonging to more than one species, and stores them in two or three cells. Sometimes only a single ant is deposited in a cell, more frequently two, rarely three. No eggs were to be found on such stored individuals, but in each of two nests, a young larva was found in a small cell devouring a single ant, which had been cut in two at the petiole. The mother *Aphilanthops* was sitting in the burrow in each of these nests and in one of them there was a paralyzed ant in a chamber separated from the one in which the larva was feeding. Several older nests were excavated in which there was a single adult larva spinning its cocoon and surrounded by fragments of three or four queen ants. These conditions seem to me to prove that the *Aphilanthops* feeds her single larva from a store of several ants deposited in several cells. The egg is evidently laid on an isolated ant which the mother wasp cuts in two in order that the larva may gain access to the nutritious contents of the thorax and gaster. Then the other ants are taken from storage and brought to the larva one by one as they are required, till all are consumed and the larva is ready to pupate. As the wasps were found in the nests even after the larvæ had pupated and

in nests containing old and empty cocoons and freshly stored ants but no larvæ, we may infer that after one larva has been reared in the manner described above the mother sets about providing for another in the same nest but in a fresh chamber. Pupæ nearly ready to hatch were found August 5 and freshly pupated young August 16; young larvæ were found on the latter date and on August 8. The larva and cocoon closely resemble those of *Cerceris rybiensis* as figured by Marchal (1887).

If my interpretation of the feeding of the larva is correct, we have in *Aphilanthops* a very interesting condition intermediate between that of the great majority of solitary wasps, which first collect provisions and then lay an egg upon them, and that of *Bembex*, which lays its egg on a single fly and feeds the hatching larva from day to day with fresh flies. If Fabre is right in supposing that *Bembex* does not always give all the captured prey to its young but keeps a portion of it temporarily out of the larva's reach in the burrow, we should have an approach to *Aphilanthops*, which brings in its store before beginning to feed its larva. This temporary storing of ants and the fact that they are not killed outright as in *Bembex*, but merely paralyzed, calls for an explanation. This, I believe, must be sought in the peculiarity of the prey, which is quite unlike that of other solitary wasps in that it can be obtained only at considerable and irregular intervals of time, namely, during the marriage flights of the various species of *Formica*. These flights may, to be sure, occur any time between the middle of July and the first of September, but nearly all the colonies in a given locality celebrate their flight on the same date and often during only a few hours, so that many days may elapse before there is another flight. And although the wasps draw their supply of prey from several different species of *Formica*, this does not very greatly improve matters. In any event, the wasps have to make hay while the sun shines and carry in as many ants as they can secure before beginning to rear the larvæ. The need of thus temporarily storing the prey also explains why it is paralyzed and not killed outright as in the case of *Bembex*, nor mutilated before it is really fed to the young. Of course, it is not impossible that the Bembecine method may also be employed by *Aphilanthops* if nuptial flights of the ants occur in quick succession so that there is no need to store the prey before

feeding it to the young, but whether this is the case or not can be determined only by future observations.

The behavior of *Aphilanthops* stands out in an interesting light by comparison with that of the other genera of Philanthidæ, *Philanthus* and *Cerceris*, which, unlike *Aphilanthops* are represented by several species in Europe as well as in North America. Fabre (1891) has given us a fascinating account of *Philanthus apivorus* (=*triangulum*), which preys on the honey bee. He shows how this wasp kills the bee outright and then gorges itself with the honey which it presses out of the body of its victim. This extraordinary behavior he explains as a necessary adaptation to the diet of the larva, as he found by experiment that the insect in this stage thrives on nitrogenous food but is poisoned if it eats honey. The great depth of the nest of *Ph. apivorus* is given as one meter. The egg is laid on a dead bee and recently killed bees are fed to the growing larva from time to time after the manner of *Bembex*. Fabre also made some observations on *Ph. coronatus* Fabr. and *venustus* Rossi (=*raptor* Lep.) and found that the former provisions its nest with larger, the latter with smaller bees of the genus *Halictus*. He believes that in these cases also the honey is expressed from the bodies of the victims, but this opinion has not been confirmed. Ferton (1905) has also studied *Ph. venustus* and enumerates 14 different species of *Halictus* and one of *Andrena* which he found in the nests. He calls attention to the depth of the burrows but says nothing about the method of feeding the larvæ;

The only American *Philanthus* whose habits have been described is *Ph. punctatus* Say. According to the Peckhams (1898) this wasp nests in very small colonies and preys on bees of the genus *Halictus*, which it kills outright, but it does not malaxate them, nor express the honey from their bodies. The main burrow of the nest reaches a length of 22 inches. The following quotation shows that the method of rearing the young is very different from that described by Fabre for *Ph. apivorus:* "We did not find distinct pockets, as the soil was very crumbly and fell in as we worked, but we came upon clumps of bees an inch or so to one side of the gallery and about three inches apart, with larvæ in different stages of development. In one nest we found 26 bees in two clumps, some of them half-eaten

and some of them fresh, but all quite dead. We have no doubt that punctatus completely provisions one pocket and closes the opening from it into the gallery, before she starts another, making a series of six or eight independent cells. The provision for one larva is probably 12 or 14 bees, the capture of which, in good weather, would be a fair day's work." Melander and Brues (1903) have seen this same species of *Philanthus* nesting in the midst of colonies of *Halictus pruinosus* Roberts, and ruthlessly preying on the bees.

We are also in possession of a number of published observations on various species of *Cerceris*. Fabre (1894) describes the habits of several of these. One of them (*C. buprestícida* Duf.) provisions its nest with Buprestid beetles, five others (*C. arenaria, ferreri, truncatella* (=4-*cincta*), *labiata* and *julii*) prey on weevils and another (*C. rybiensis* =*ornata*) preys on bees of the genera *Halictus* and *Andrena*. Marchal (1887) shows, in a beautiful study of this last species, that the wasp not only stings the bee but also crushes, or malaxates the back of its neck and laps up the exuding juices and honey. As a result of this treatment the bee dies in the course of a few hours. Adlerz (1900, 1903) lists *C.* 5-*fasciata, arenaria* and *truncatella* as provisioning their nests with weevils, *C. hortivaga* as preying on bees of the genus *Hylæus* and *C. labiata* as collecting both Chrysomelid and Curculionid beetles. Ferton (1901, 1905) cites *C. specularis, truncatella* and *ferreri* as preying on weevils, *C. emarginata* on bees of the genera *Halictus, Prosopis* and *Andrena*, and *C. magnifica* on *Halictus* and *Andrena*. This last species laps the honey from the body of its victim through a hole made in the back of its neck, as described by Marchal in the case of *C. rybiensis*.

The Peckhams (1898, 1900) find that the American *C. clypeata* Dahlb., *deserta* Say and *nigrescens* F. Smith all prey on weevils, like the majority of European *Cerceris*, but that *C. fumipennis* Say preys on a Buprestid beetle, *Chrysobothris* 4-*impressa*, which it kills outright. In all the species of *Cerceris* observed up to the present time the cell is first provisioned with numerous specimens of the prey, the egg is then laid and the cell closed as in the great majority of solitary wasps.

It would seem, therefore, that the method of rearing the young in *Aphilanthops* is intermediate between that of *Cerceris* and *Philanthus punctatus* on the one hand and of *Ph. apivorus*

on the other. The question then presents itself: Do *Ph. apivorus* and *A. frigidus* represent an advance on *Cerceris* or are the conditions in this genus derived from those of *Ph. apivorus?* In other words, is the Bembecine a primitive or a secondary method of caring for the young among the solitary wasps? Undoubtedly most observers would be inclined to regard *Bembex* as representing a later phylogenetic stage and one leading to the conditions in the social wasps, but the Peckhams take a different view. "It may be possible, then," they say, "that all wasps originally fed their larvæ from day to day as *Bembex* now does, and that while the instinct of paralyzing the prey and of storing the whole supply of food once for all was working itself out among the solitary wasps, the instincts connected with life in a true society, and of joining together in the work of feeding the larvæ, have, on the other hand, developed into those of our wasp communities."

It is difficult to decide between the evolutionary alternatives here indicated, but analogy with the phylogenetic history of the bees, in which two precisely similar methods of rearing the young occur, certainly points to the Bembecine method as secondary. This view is also sustained by the sporadic and independent occurrence in several highly specialized groups of wasps of this method as the one best adapted to certain peculiar conditions. Such cases are *Aphilanthops frigidus* and *Philantus apivorus*. Two others are cited by the Peckhams, one in the genus *Sphex* (*Ammophila*), where they found "an instance which looks like a connecting link between the habits of *Bembex* and those of the solitary species. *A. urnaria* stores one caterpillar, lays an egg on it, catches another and stores it as soon as she can and then closes the nest. As a usual thing, no doubt, the nest is finally closed before the egg is hatched, so that she never sees her larva. In one of our instances, however, the capture of the second caterpillar was so much delayed that when it was brought in the mother wasp found a larva of a day old feasting on the one already provided." The other case is that of *Lyroda subita* Say, which these authors found to resemble *Bembex* in feeding its larva from day to day on small crickets. Most instructive in this connection, however, is the *Aphilanthops*, because its method of collecting a supply of queen ants before feeding them one by one to the growing larva, indi-

cates very clearly that this wasp originally had the storing habits of the allied genus *Cerceris* and of *Philanthus punctatus* and has secondarily acquired the Bembecine method of feeding its young. I am, therefore, inclined to regard the Bembecine method as derivative, or secondary, and find further confirmation of this view in the fact that in all cases, except *Lyroda*, the prey of those solitary wasps which feed their larvæ from day to day, belongs to highly specialized groups of insects of comparatively recent phylogenetic origin—ants in the case of *Aphilanthops*, honey bees in the case of *Philanthus apivorus* and higher Diptera in the case of *Bembex*.

The species of *Aphilanthops* are not the only solitary wasps that prey on ants, for some four small Mediterranean Crabronids, belonging to two genera, are known to provision their nests with these insects. Ferton (1890) describes the habits of *Fertonius luteicollis* Lep. in Algiers, where it digs its nest in sandy soil, making burrows only about 4 cm. deep, but also nests in the crevices of walls. It preys exclusively on workers of *Tapinoma erraticum* Latr., storing in each cell 40 to 50 of these strong-smelling ants, which are merely paralyzed and far from motionless at first. There are three generations of the wasps in the course of the year. Later (1895) Ferton described from Corsica a second species of the same genus (*F. formicarius* Fert.) which also preys on *Tapinoma erraticum* workers and closely resembles *F. luteicollis* in its other habits. In 1893 Emery described the habits of *Brachymerus curvitarsis* H. Sch., a Crabronid that preys on the workers of *Liometopum microcephalum* Panz. in Italy. He saw it pounce on the ants as they were moving along in files. The nest was found in a fig-tree, in the abandoned burrows of a longicorn beetle. The ants were stored in numbers (about 40) in each cell and were "imparfaitement paralysés, quelques uns capables même de se trainer sur leur pattes." More recently (1901) Ferton has figured a second species of the same genus (*B. 5-notatus* Jur.) which, like the species of *Fertonius*, preys on workers of *Tapinoma erraticum*.

It is interesting to note that all of these Crabronids prey on strong-smelling ants of the subfamily Dolichoderinæ and that they select only the workers. Ainslee's observations show that the latter statement is also true of *Aphilanthops taurulus* but

that in this case Myrmicine ants are selected. *A. frigidus,* as I have shown, confines its depredations to Camponotine ants of the genus *Formica* and selects only the queens, which are, of course, the largest and most nutritious caste. This specialization in diet, while highly advantageous to the wasps, is very destructive to the ants, since each fecundated queen is really a potential colony. Still the prey preferred by *frigidus*, namely *F. fusca* and its var. *subsericea*, notwithstanding the depredations of the wasps and of our numerous slave-making and temporarily parasitic species of *Formica*, maintain their status as far and away the most abundant ants of their genus in the northeastern states and Canada. They are able to support this greedy host of prædators and parasites because they are extremely prolific, hardy, or eurythermic, and of a very industrious and peaceable disposition.

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The Ants of Haiti.

By W. M. Wheeler and W. M. Mann.

AUTHOR'S EDITION, extracted from BULLETIN

OF THE

American Museum of Natural History,

Vol. XXXIII, Art. I, pp. 1–61.

New York, February 20, 1914.

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BULLETIN

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY.

VOLUME XXXIII, 1914.

59.57.96(729.4)

Article I.— THE ANTS OF HAITI.[1]

BY W. M. WHEELER AND W. M. MANN.

THE following paper is based on a large series of Formicidæ taken in the republic of Haiti by the junior author during the winter of 1912–'13, while he was collecting zoölogical specimens for the Museum of Comparative Zoölogy and Mr. B. Preston Clark of Boston. Although San Domingo was not visited, it seemed desirable to enumerate also the few species known from that country as well as all previous records from Haiti proper. As the naturalist is apt to encounter peculiar obstacles in carrying on work in the island, the junior author wishes to express his appreciation of the kindness of a number of gentlemen who assisted him in obtaining transportation, letters of introduction and living accommodations. M. Tancrède Auguste, the late president of Haiti, gave him general permission to travel throughout the republic, and Archbishop Conan kindly furnished him with letters to the priests of his diocese, the only gentlemen with whom it was possible at times to secure lodgings. Father Plomby of Furcy, Father Braun of Grande Rivière and the Abbé Meliande of Milot befriended and lodged him, not only once but on several occasions. Mr. Willoughby, chief engineer of the American railroad now being built through Haiti, looked after his welfare in the construction camps, as did also Messrs. Wilkinson and Shea in the northern part of the republic. Dr. John B. Terres welcomed him in his home at Diquini, a short distance to the west of Port au Prince. This was an ideal spot for collecting and the genial doctor himself took a personal interest in the work and collected many desirable specimens. The junior

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University. No. 72.

author also passed several days on the enormous sugar plantation at Momance, as the guest of its owner, Gen. J. F. Jeffrard. In the north, headquarters were made at Charmette, near Cape Haitien, in the home of an American, Mr. W. M. Kirchner, who is engaged in growing cotton. Dr. Henry Furniss, United States minister to Haiti, gave much useful advice and assistance, and Messrs. Moore and Furbush of the American legation, Messrs. Baptiste and Livingston of the Consular service, Mr. J. H. Allen of the National Bank, Mr. Johnson of Jacmel, Capt. Gatchal of Port au Prince, and, in fact, all the members of the American colony greatly facilitated traveling and residence and were of material assistance in many other ways.

The following is a list of some of the localities cited for the various species enumerated in the following paper, with notes on their peculiarities: —

Diquini. The residence of Dr. John B. Terres, United States Consul General, near Bizaton, west of Port au Prince and among low hills. Cultivated ground and open woods along a stream made this a rich field for the collector.

Momance. The sugar-cane plantation of Gen. Jeffrard, on the railroad between Port au Prince and Laogane; flat, cultivated country, a little above sea-level.

Manneville. On the west shore of Lake Assuei; hot and dry, with desert vegetation, such as cacti and thorny bushes; with a few small, sporadic, cultivated tracts. This locality is scarcely above sea level.

Petionville (*Le Coup*). The summer resort of Port au Prince; about three miles inland and at an altitude of about 500 m. Most of the collecting here was in shady ravines and on the hill slopes back of the town.

Furcy. A small settlement in the high mountains south of Port au Prince, at an altitude of 1730 m.[1] Collecting here was mostly along the mountain ridge or in the cañons on each side. Owing to the altitude the climate is delightful, though the nights are rather too cool for comfort. There is a curious intermingling of tropical and temperate vegetation, pine trees growing with coffee-plants and bananas among patches of Indian corn. Numerous insects seemed to be peculiar to this region, notably *Macromischa sallei* subsp. *haytiana* which was taken only here and as the commonest insect. It is not improbable that each of the mountain ranges of Haiti has its own faunal peculiarities.

Mountains north of Jacmel. A region on the eastern fork of the river

[1] The altitude of Furcy is stated variously by different authors. Léger (Haiti, Her History and Her Detractors. Neale Pub. Co., New York and Washington, 1907, p. 275) gives it as 1,540 meters. A map in the presbytère of the chapel at Furcy had it marked 1,730 m.

which flows southward and enters the sea at Jacmel. The exact location of the collection cannot be given, but, roughly speaking, it was along the river about a ten hours' horse-back journey from Jacmel.

Cape Haitien. Collections mostly from Charmette, the plantation of Mr. Kirchner, some three miles southeast of the town.

Grande Rivière. A few miles beyond the town on the right of way of the railroad now under construction at the camps of Messrs. Wilkinson and Shea.

Milot. On the trail between Milot and the citadel of Christophe.

Up to the present time our knowledge of the ants of Haiti has remained very meager. Latreille, Guérin, Frederick Smith and Roger long ago described a few species from San Domingo, and more recently Emery and Forel have recorded several others from a few specimens taken by various collectors in Haiti. Altogether, however, not more than two dozen forms have been recorded from the whole island. In the present paper 90 forms are recognized, 37 of which are described as new to science. The whole series may be divided into three groups: those known only from the island of Haiti, those common to other West Indian Islands and the adjacent tropical mainland (Central and South America) and those which are tropicopolitan and therefore, in all probability, introduced by commerce. The following 47 or 52.2% of all the forms are known only from the republic of Haiti and San Domingo:

Platythyrea strenua
Emeryella schmitti
Spaniopone haytiana
Trachymesopus rufescens
Lobopelta antillana
Stenomyrmex haytianus
Odontomachus paucidens
Pseudomyrma haytiana
" affinis
" torquata
" subatra
Solenopsis inermiceps
Pheidole terresi
" illota
" haytiana
" creola
Aphænogaster relicta
" epinotalis
Ephebomyrmex schmitti
" sublævigatus
" saucius
Macromischa sallei
" haytiana
" flavidula
Cryptocerus hæmorrhoidalis
" marginatus
Trachymyrmex haytianus
Iridomyrmex keiteli
" flavescens
" subfasciatus
Tapinoma opacum
Rhizomyrma parvidens
" dubitata
Camponotus plombyi
" haytianus
" fraterculus
" soulouquei
" illitus
" imbecillus
" larvigerus
" ulysses
" sublautus
" furnissi
" occultus
" christophei
" augustei
" toussainti

The forms common to other West Indian Islands or to the tropical mainland are 34 in number and constitute 37.7 % of the whole known ant fauna:

Platythyrea punctata
Trachymesopus stigma
Ponera opaciceps
" ergatandria
Leptogenys puncticeps
Anochetus mayri
Odontomachus haematoda
" insularis
Pseudomyrma delicatula
" cubaënsis
Cardiocondyla venustula
Solenopsis geminata
" globularia
" borinquenensis
" pollux
Crematogaster steinheili
Pheidole jelskii
Pheidole antillensis
" vincentensis
" jamaicensis
Wasmannia auropunctata
Strumigenys alberti
" rogeri
" unispinulosa
Trachymyrmex jamaicensis
Mycocepurus smithi
Cyphomyrmex minutus
Dorymyrmex niger
Brachymyrmex heeri
Nylanderia itinerans
" steinheili
" fulva
Camponotus ustus
" sexguttatus

Only 9 forms or 10 % belong to the tropicopolitan group:

Monomorium salomonis
Monomorium floricola
" ebeninum
Pheidole megacephala
Tetramorium guineense
Tetrogmus simillimus
Tapinoma melanocephalum
Nylanderia longicornis
" hagemanni

For the sake of comparing the three groups of forms recorded above with the corresponding groups in the other Great Antilles, Cuba, Jamaica and Porto Rico (including the Virgin Islands), the following table has been compiled from former papers by the senior author:

Greater Antilles	Forms peculiar to each Island.	Forms common to other Antilles or Mainland.	Tropicopolitan (" tramp ") species	Total number of forms
Cuba	34(43.1%)	37(46.8%)	8(10.1%)	79
Haiti	47(52.2%)	34(37.7%)	9(10.%)	90
Jamaica	17(26.9%)	37(58.7%)	9(14.3%)	63
Porto Rico	14(22.2%)	39(61.9%)	10(15.8%)	63

It will be seen from this table that the number of species, subspecies and varieties of ants is less in the two smaller than in the two larger Great Antilles, though greater in Haiti than Cuba, that each of the islands has 8–10

tropicopolitan "tramp" species and that the number of widely distributed neotropical forms is nearly the same in all the islands, varying only from 34–39.[1]

The greatest interest attaches to the forms peculiar to each island. These, which vary considerably, from only 15 and 17 on Porto Rico and Jamaica to 34 and 47 on Cuba and Haiti, comprise species, subspecies and varieties, and most of the subspecies and varieties represent merely local races of species which occur elsewhere in tropical America. An enumeration of the species peculiar to each island gives a different proportion, Cuba having 21, Haiti 19, Jamaica 9 and Porto Rico 7 species, which are known to occur in no other part of the world. These may, therefore, be regarded as truly indigenous forms or relicts of some ancient fauna, whereas the subspecies and varieties peculiar to each island are presumably, in great part at least, of more recent development. The latter may therefore be called "recently indigenous," the former "primitively indigenous" forms, whereas those which are common to two or more of the Antilles or to Central or South America, may be designated as "widely ranging." It is evident, however, that this can be only a rough classification since some of the widely ranging forms may have been quite as long on the islands as some of the recently or even primitively indigenous forms, but may belong to very stable species, which have undergone very little or no modification in response to differences of geographical environment.

It is certain, nevertheless, that what we have called the primitively indigenous forms are the most distinctive and striking component in the ant-fauna of each island. In Haiti this component, as previously stated, comprises 19 species. Two of these, *Emeryella schmitti* and *Spaniopone haytiana*, also represent genera peculiar to the island. The only other Antille known to have a peculiar genus (*Nesomyrmex*) is Grenada. Both *Emeryella* and *Spaniopone* belong to the Ponerinæ, the most primitive of the five subfamilies of Formicidæ, the former allied to the neotropical subgenus *Gnamptogenys* of the genus *Ectatomma*, the latter allied to *Proceratium* and *Sysphincta*, but more primitive and more like the extinct *Bradoponera* of the Baltic amber and *Discothyrea*, a small and evidently very ancient genus, with discontinuous distribution (Central America, New Guinea). Three other Ponerinæ, *Platythyrea strenua*, *Lobopelta antillana* and *Stenomyrmex haytianus* are also confined to Haiti. In addition to these there is a peculiar *Solenopsis* (*S. inermiceps*), two species of *Ephebomyrmex* (*E. schmitti* and

[1] Since the publication of the senior author's paper on the Ants of Cuba, Bull. Mus. Comp. Zoöl., LIV, 1913, pp. 477–505, two additional forms have been found among material from the island, namely *Crematogaster victima* F. Smith subsp. *steinheili* Forel and *Monomorium destructor* Jerdon.

saucius), a subgenus of *Pogonomyrmex*, a peculiar *Aphænogaster* (*A. relicta*), two species of *Macromischa* (*M. sallei* and *flavidula*), an aberrant *Cryptocerus* (*C. hæmorrhoidalis*), a distinct *Iridomyrmex* (*I. keiteli*), a *Tapinoma* (*T. opacum*) and two extraordinary species of *Camponotus* (*C. christophei* and *toussainti*). *Pogonomyrmex*, a genus well-represented in the Western United States, Mexico, Guatemala, Eastern Brazil and western and southern South America, occurs no where else in the West Indies. *Camponotus christophei* and *toussainti* are closely allied to a very peculiar species (*C. saussurei*) known only from St. Thomas. Another striking peculiarity of the Haitian fauna is displayed in the great development of forms belonging to the *C. maculatus* group. This is very poorly represented in Cuba, Jamaica and Porto Rico. Affinities of the Haitian with the Cuban and Porto Rican ant-faunas are indicated by the species of *Macromischa*, a genus best represented in Cuba (with nine species), but not known to occur in Jamaica, though represented by a few species in Mexico, Texas and the Bahamas. On the other hand, special affinities with the Jamaican fauna are indicated only by *Trachymyrmex jamaicensis*, which is also found in the Bahamas, but is not known to occur in Cuba.

Subfamily Ponerinæ.

1. **Platythyrea strenua** sp. nov. (Fig. 1.)

Worker. Length 8–8.5 mm.

Body rather stout. Head subrectangular, excluding the mandibles less than 1½ times as long as broad, with very feebly convex sides and very feebly concave pos-

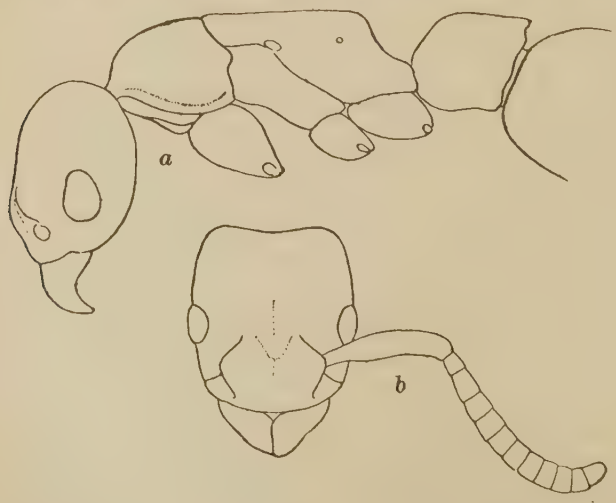

Fig. 1. *Platythyrea strenua* sp. nov. Worker. a, profile of head, thorax and petiole; b, head of same from above.

terior border. Eyes rather large and flat, nearly as long as their distance from the anterior border of the head and a little in front of the middle of its sides. Mandibles edentate, rather flat, their external borders very feebly concave near the tips. Clypeus flat, with broadly rounded anterior border, and indistinct posterior suture. Frontal area and frontal groove distinct, the former elliptical, about twice as long as broad. External borders of the flattened frontal carinæ bluntly angular. Antennal scapes reaching to the posterior corners of the head; second and terminal funicular joints longer than broad, remaining joints as broad as long. Thorax unarmed, narrower than the head, broader in front than behind, with flattened sides and dorsal surface, so that the latter appears submarginate laterally. Epinotal declivity concave, forming a distinct angle in profile with the base and surrounded on the sides and above with a distinct ridge. Petiole subcuboidal, from above but little longer than broad, as broad in front as behind, but narrower than the epinotum, its posterior border above and in the middle but slightly and very bluntly produced backward and very feebly, sinuately excised on each side. Gaster nearly twice as broad as the petiole, its first segment a little broader than long, the second as long as broad. Legs rather stout.

Body and appendages opaque, very finely and densely punctate, gaster slightly shining, sides of first gastric segment, mandibles and cheeks also with slightly larger, but by no means coarse punctures.

Hairs lacking, except on the tips of the mandibles and gaster and on the palpi, where they are very short. Pubescence very fine, yellowish gray, covering the body and its appendages with a uniform bloom.

Black; mandibles, clypeus, frontal carinæ, antennæ, tarsi and articulations of legs tinged with dull red; terminal gastric segments pale red.

Described from several workers taken at Diquini, from a rotten log, in close proximity to a termite colony.

This is clearly distinct from any of the five known neotropical species of *Platythyrea.* It is larger and more robust than *punctata* Smith, *meinerti* Forel and *angusta* Forel, darker in color than *meinerti*, which is brown and differs also in the shape of the petiole. *P. strenua* is also peculiar in lacking the coarse punctuation of *angusta* and *punctata.* From *sinuata* Roger it differs in lacking the mandibular teeth and from *incerta* Emery, which it resembles in size and in its more robust stature, it may be distinguished by the absence of coarse punctures on the head and mandibles, by the smaller frontal carinæ, the more distinct frontal groove, etc.

2. **Platythyrea punctata** F. Smith.

Catalog. Hymen. Brit. Mus. VI, 1858, p. 108 ♀ ♂.

This species was originally described from San Domingo, but has since been found to be widely distributed through the West Indies, Central and northern South America. The junior author has taken it at Cape Haitien, Grande Rivière and Milot, running about on the ground in shady places.

3. **Emeryella schmitti** *Forel.* (Figs. 2 and 3.)

Ann. Soc. Ent. Belg., XLV, 1901, p. 334, ☿ .

Worker. Length 7–9 mm.

Head large, subrectangular, broader than long, broader in front than behind, with rather straight sides and feebly excised posterior border. Eyes moderately large, at the middle of the sides of the head. Mandibles longer than the head, inserted far apart at its anterior corners, sublinear and curved, somewhat broader at the base, obliquely truncated at the tip, with a large, blunt, triangular tooth at

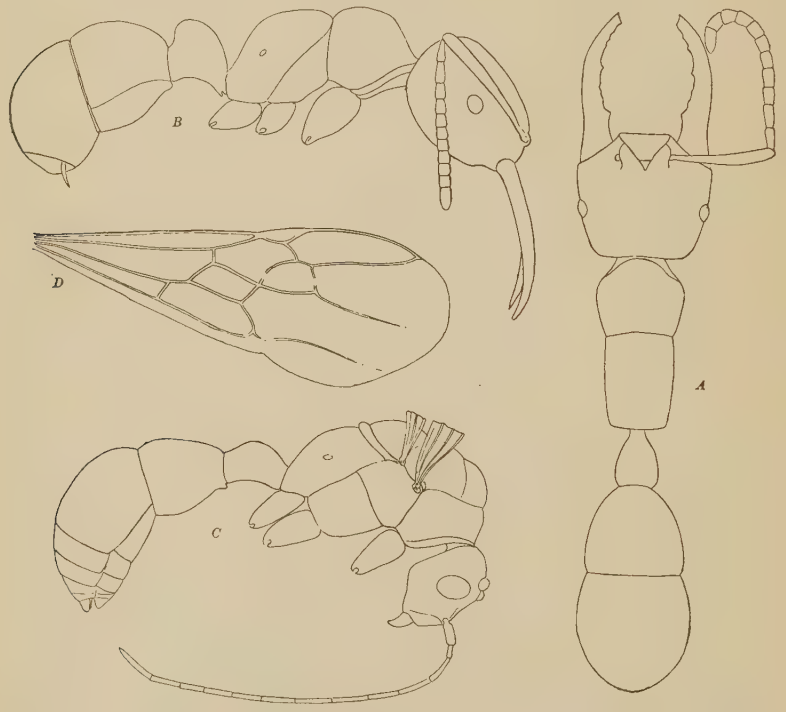

Fig. 2. *Emeryella schmitti* Forel. A, dorsal view of worker; B, profile of worker; C, profile of male; D, wing of male.

the basal third and a few indistinct, widely separated denticles on the most distal portion of the internal border. Clypeus very short, its anterior border in the middle straight, excised on the sides at the insertions of the mandibles, its median surface rather flat. Frontal carinæ very short, about as far apart as each is from the lateral border of the head. Frontal area distinct, triangular. Antennal scapes slightly curved, their tips extending a short distance beyond the posterior corners of the head; funicular joints 1–4 distinctly longer than broad, the second longest; joints 5–10 scarcely longer than broad, terminal joint as long as the two preceding taken together. Thorax short and robust, much narrower than the head, broadest

through the pronotum which has rounded, convex sides and dorsum. Promesonotal suture deep. Meso- and epinotum not separated by a suture, together but little longer than the pronotum including the neck. The base of the epinotum, which is unarmed, straight above in profile and passing into the concave or flattened declivity through a rounded angle. Petiole longer than broad, narrower in front than behind, about as long as high, in profile rounded and convex above, with a more abrupt posterior declivity to the node; ventrally with a small tooth at its anterior border. Gaster more than twice as broad as the petiole, short, its first segment campanulate, as broad as long, with a strong tooth on its anterior ventral border; second segment somewhat longer than broad, very convex dorsally, remaining segments small, telescoped into the second segment and directed forward. Sting small. Legs rather long.

Somewhat shining; mandibles coarsely and sparsely punctate; head and pronotum sharply longitudinally rugose; meso- and epinotum and petiolar node transversely rugose; first gastric segment in front with arcuate rugæ which enclose behind a space that is longitudinally rugose; second segment with much coarser and sharper rugæ converging at the anterior and posterior borders of the segment. Antennal scapes and legs covered with small piligerous punctures.

Hairs short, coarse, grayish, erect on the body, shorter and more reclinate on the appendages.

Black, with a slight reddish tinge, which is more pronounced on the mandibles, antennæ, tarsi and articulations of the legs; terminal segments of gaster paler red or brownish.

Male. Length 6–7 mm.

Head, including the mandibles, a little longer than broad, very convex and rounded behind, with large, convex eyes and ocelli. Clypeus moderately convex, with broadly and feebly excised anterior border. Frontal area distinct, triangular; frontal carinæ very small. Mandibles small, triangular, pointed, with a few distinct teeth on the base of their apical border. Antennæ very long; funicular joints 2–13 slender, cylindrical and subequal, first joint somewhat longer than broad, distinctly shorter than the third joint. Thorax rather short and robust, mesonotum with pronounced Mayrian furrows; epinotum sloping, rounded, unarmed, without distinct base or delivity. Petiole nearly twice as long as broad, scarcely narrower in front than behind, above with a very low, rounded node and below feebly concave in profile, with a minute tooth at its anterior end. Gaster similar to that of the worker, but the first and second segments more slender and the terminal segments more developed and not turned forward. First segment with a median longitudinal ridge on the dorsal side. Genitalia very small. Hypopygium minute, bluntly triangular. Cerci present. Legs long, and slender. Wings rather narrow.

Body shining. Mandibles, head and posterior portion of mesonotum punctate and finely, longitudinally striate. Surface of epinotum, petiole and first gastric segment uneven but scarcely rugose, the epinotum with coarse, scattered punctures. Second and following segments smooth and shining and like the legs, covered with minute piligerous punctures.

Hairs yellow, erect and abundant, both on the body and appendages.

Uniformly red; antennæ beyond the second joint fuscous; wings infuscated, with blackish veins and stigma.

Described from numerous workers and four males collected at Diquini

and Petionville.[1] Although the males were not taken in the nests but at lights, we believe there can be no doubt about their identity. The larvæ and pupæ taken from the nests are peculiar, the former resembling the larvæ of *Stigmatomma pallipes*, described many years ago by the senior author, in being very broad behind and very narrow and curved anteriorly and instead of being tuberculate, have the body covered with dense, soft, erect hairs. The pupae are enclosed in cocoons which are dark brown and singularly short and broad and obtuse at the ends.

This extraordinary ant, which both Forel and Emery believe to be most closely related to *Gnamptogenys*, a subgenus of *Ectatomma*, though the structure of the head bears a strange superficial resemblance to that of the

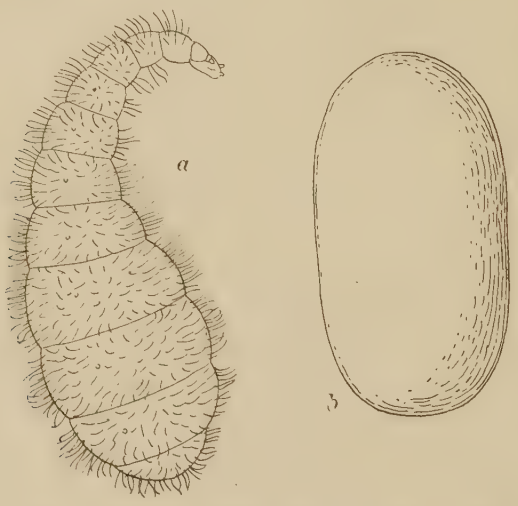

Fig. 3. *Emeryella schmitti* Forel. a, larva; b, pupa.

species of *Amblyopone*, *Stigmatomma* and *Mystrium*, has been known hitherto from only a single worker, which was sent to Forel by Rev. P. J. Schmitt, O. S. B. It is certainly a rare species even in Haiti and was found by the junior author only on three occasions. At Petionville a single worker was captured in a humid spot near a little stream. At Diquini, in a shaded place, also near a stream, two colonies were found, one under a stone and one by following up a worker that was out foraging in the late afternoon. This worker was carrying a Polydesmid Diplopod thrown over its body in such a manner that the ant was entirely concealed beneath its burden. The

[1] We have recently received several more males of *E. schmitti* from Dr. Terres, who took them at light at Diquini.

opening of the nest was circular and about $\frac{1}{4}$ of an inch in diameter, and led into a tunnel beneath a stone where some of the workers were gathered, though most of them, together with the larvæ and pupæ, were in chambers deeper in the earth, some six or seven inches below the surface. Scattered about in the nest were numerous fragments and several entire examples of a species of Polydesmid and of another Diplopod allied to our northern *Julus*. This fact, together with the behavior of the worker described above, indicates that *E. schmitti* feeds chiefly or entirely on Myriopods. The workers move slowly and deliberately like those of *Ectatomma tuberculatum* and *ruidum*. They seem to be very timid and secrete themselves when the nest is excavated. Probably they are crepuscular. The males are attracted to lights, all the specimens having been taken at night by Mr. J. B. Terres on the verandah of his house at Diquini.

Spaniopone gen. nov.

Worker. Allied to *Proceratium* Roger. Head shaped as in this genus, with minute eyes just behind the middle of its sides. Mandibles triangular, with indistinct denticles on their apical borders. Clypeus much larger than in *Proceratium*, with broadly rounded anterior border and its posterior border separated by a distinct suture from the front and cheeks and not wedged in between the frontal carinæ. These are well-developed but short, not covering the insertions of the antennæ, nearer together than each is from the side of the head, with feeble flattened lobes anteriorly and somewhat diverging posteriorly. Antennæ 12-jointed; scapes slightly enlarged but not incrassated at their tips; funiculi with a distinct 3-jointed club; first funicular joint longer than broad; joints 2–8 transverse but growing longer distally; joints 9 and 10 subequal, as long as broad and broader than the preceding joints; terminal as long as the three preceding joints together. Thorax shaped much as in *Proceratium*, but unarmed and with distinct pro-mesonotal and mesoëpinotal sutures. Petiole decidedly transverse, somewhat less squamiform than in *Proceratium*, the anterior surface being flattened; the upper rounded in profile and the posterior very short. First gastric segment fully as long and as large as the second, which is very convex above. Remaining segments small, forming a cone which is directed downward and forward. Tarsal claws simple; tibiæ with but a single spur.

4. **Spaniopone haytiana** sp. nov. (Fig. 4.)

Worker. Length 2.5 mm.

Head subrectangular, about $\frac{1}{3}$ again as long as broad, as broad in front as behind, with feebly convex sides and feebly and broadly excised posterior border. Mandibles with straight external and apical borders, the latter passing into the basal border through a distinct though rounded angle. Clypeus convex. Antennal scapes more than half as long as the funiculi, not reaching the posterior corners of the head. Pronotum with rounded humeri, rather flat above, somewhat broader than long, mesonotum twice as broad as long. Epinotum from above slightly broader than

long, in profile with the base short and passing rather abruptly through a rounded angle into the longer declivity. Petiole from above as broad as the epinotum, fully twice as broad as long, with rounded dorsal surface, subpedunculate in profile; its anterior slope is long and flattened, its summit rounded and its declivity very short. On the ventral side it bears a blunt tooth at its anterior border. First gastric segment as long as broad, with a small transverse swelling on its ventral surface near the anterior edge. Legs rather slender.

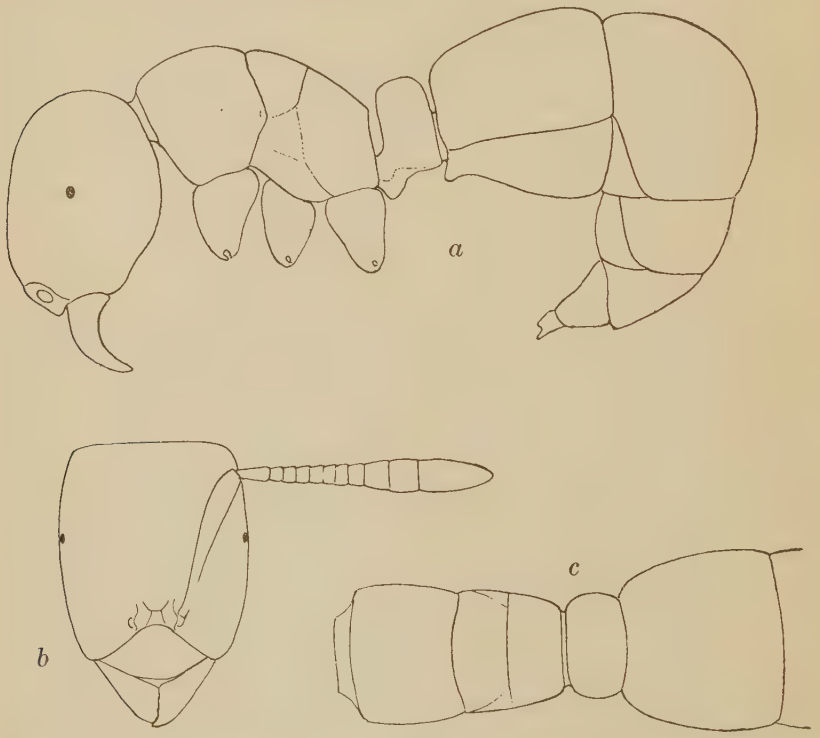

Fig. 4. *Spaniopone haytiana* sp. nov. Worker. a, profile; b, head from above; c, dorsal view of thorax, petiole and first segment of gaster.

Body opaque; mandibles, second and succeeding gastric segments shining; mandibles coarsely striato-punctate. Head delicately longitudinally rugulose; thorax, petiole and first gastric segment very finely punctate and indistinctly rugulose; first and second gastric segment very finely, transversely striated.

Hairs whitish, fine, rather abundant, suberect on the body, shorter and more appressed on the legs.

Color brownish yellow; mandibles slightly reddish, with black apical borders. The second and succeeding gastric segments and the legs slightly paler, the funiculi darker.

Described from a single specimen taken in the mountains north of Jacmel on a moist hill-side beneath a fallen banana stalk. It has been

necessary to erect a new genus for this singular ant, because it is obviously neither a *Proceratium* nor a *Sysphincta*, as shown by the structure of the clypeus, frontal carinæ, petiole and first gastric segment, the clubbed antennæ and the distinct thoracic sutures, though it is undoubtedly closely related to the first of these genera and must be included in the tribe Proceratini, as defined by Emery (Gen. Insect., Ponerinæ, p. 49). That it is a very primitive member of the group is indicated by the persistence of the thoracic sutures and the characters of the head, excepting the eyes. The reduction of these organs proves that it is hypogæic in habit like our northern species of *Proceratium* and *Sysphincta*.

5. **Euponera (Trachymesopus) stigma** *Fabr.*

Formica stigma Fabricius, Syst. Piez., 1804, p. 400. ☿.

Numerous workers and deälated females from Petionville, Manneville and Diquini. This ant is also recorded by Forel (Mitth. Naturh. Mus. Hamb. XXIV, Beiheft, 1907 p. 1) from St. Marc, Haiti.

6. **Euponera (Trachymesopus) stigma** *Fabr.* var. **rufescens** var. nov.

Worker. Differing from the worker of the typical form and the var. *attrita* Forel, in its smaller size and in coloration. It measures only 3.5–4.5 mm., and is red instead of black, with the top of the head in some specimens darker and more brownish.

Female (deälated). Indistinguishable in color, sculpture and size from the typical *stigma*.

Described from nine workers and a single female taken on the shore of Lake Assuei at Manneville. These were all from the same colony, which was nesting in the moist sand beneath a log. The workers cannot be immature as such individuals have a drab color in the typical *stigma*.

7. **Ponera opaciceps** *Mayr.*

Verh. zool. bot. Ges. Wien, XXXVIII, 1887, p. 536, ☿ ♀.

Numerous workers from Diquini, Grande Rivière and the mountains north of Jacmel.

8. **Ponera ergatandria** *Forel.*

Trans. Ent. Soc. London, 1893, p. 365, ☿ ♀ ♂.

Numerous workers from Ennery, Manneville, Grande Rivière and Diquini.

9. **Leptogenys puncticeps** *Emery.*

Ann. Soc. Ent. France (6), X, 1890, p. 62, *nota*, ♀ .

Six workers and a male taken at Diquini and Grande Rivière agree closely with Emery's description of the types from Costa Rica and some workers taken by Prof. C. T. Brues in the island of Grenada. Forel described from St. Vincent a variety *vincentensis* which Emery (Gen. Insect. Ponerinæ, p. 100) refers to this species, but which Forel referred to *pubiceps* Emery (Rev. Suisse Zool., IX, 1901, p. 328). The nest of *L. puncticeps* at Diquini was in the ground, beneath débris, in an unused tobacco shed.

10. **Leptogenys (Lobopelta) antillana** sp. nov. (Fig. 5.)

Worker. Length 4.5–5.5 mm.

Body slender. Head about $1\frac{1}{3}$ times as long as broad, a little broader in front than behind, with rather straight sides and posterior border. Eyes small, shorter

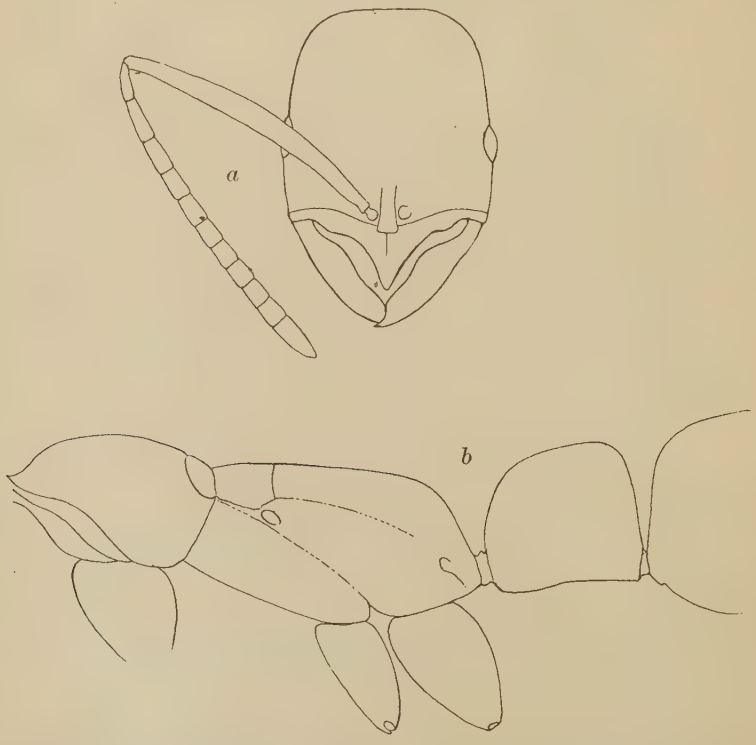

Fig. 5. *Leptogenys* (*Lobopelta*) *antillana* sp. nov. a, head of worker from above; b, thorax and petiole of worker in profile.

than their distance from the anterior corners of the head. Mandibles narrow but with distinct apical and basal borders. Clypeus very strongly carinate, with an anterior, median, beak-like point, filling the space between the mandibles when they are closed. Antennæ slender; scapes extending a little more than their greatest diameter beyond the posterior border of the head; funicular joints 1–5 decidedly longer than broad, the second longest, joints 6–10 only slightly longer than broad. Thorax in front as broad as the head, pronotum as broad as long, meso- and epinotum together longer than the pronotum, in profile with straight dorsal surface about twice as long as the declivity which is feebly convex. Petiole from above $1\frac{1}{2}$ times as long as broad, twice as broad behind as in front, the node laterally compressed, in profile as high as long, as high in front as behind, evenly rounded above, with short, abrupt, rounded anterior and posterior declivities. Gaster and legs slender.

Smooth and shining. Mandibles with a few coarse punctures along their internal borders.

Hairs whitish, short, suberect or reclinate, not very abundant on the body, more abundant and shorter on the scapes and legs.

Black; mandibles, funiculi, bases and tips of scapes, tarsi, knees, tips of tibiæ and tip of gaster red or reddish brown.

Described from seven specimens taken at Milot, Diquini and Petionville.

This species closely resembles *L. consanguinea* Wheeler of Mexico, but the mandibles are broader, with a distinct apical border, the petiole is of a very different shape, the antennal scapes are shorter and the pilosity is longer and more abundant.

11. **Anochetus mayri** *Emery.*

Emery, Ann. Mus. Civ. Genova, XXI, 1884, p. 378, ☿ ; Ann. Soc. Ent. France (6), X, 1890, p. 65, ☿ ♀.

Numerous workers and females from Manneville, Grande Rivière, Diquini, Milot and the mountains north of Jacmel.

12. **Anochetus (Stenomyrmex) haytianus** sp. nov. (Fig. 6 *d*, *e* and *f*.)

Worker. Length 6.5–7.5 mm.

Differing from *emarginatus* Fabr. in the following structural characters: The head is much broader behind, the mandibles shorter, with fewer (4 to 5) denticles on their inner borders and slightly shorter apical teeth. The antennal scapes and all the funicular joints are distinctly shorter, the former extending less than $\frac{1}{4}$ their length beyond the posterior corners of the head. The epinotum is quite unarmed, low and rounded in profile. The petiole is more erect, with subequal anterior and posterior declivities and at the summit with two teeth which are longer, more acute and more diverging than in *emarginatus*.

Body smooth and shining; pronotum finely and longitudinally, meso- and epinotum more coarsely and transversely rugose; front of head also finely longitudinally rugose, the rugæ diverging posteriorly.

Hairs very sparse as in *emarginatus* and confined to the mouth and gaster.

Color brownish yellow, legs, mandibles and antennæ paler, the tint throughout being lighter than in *emarginatus* subsp. *testaceus* Forel.

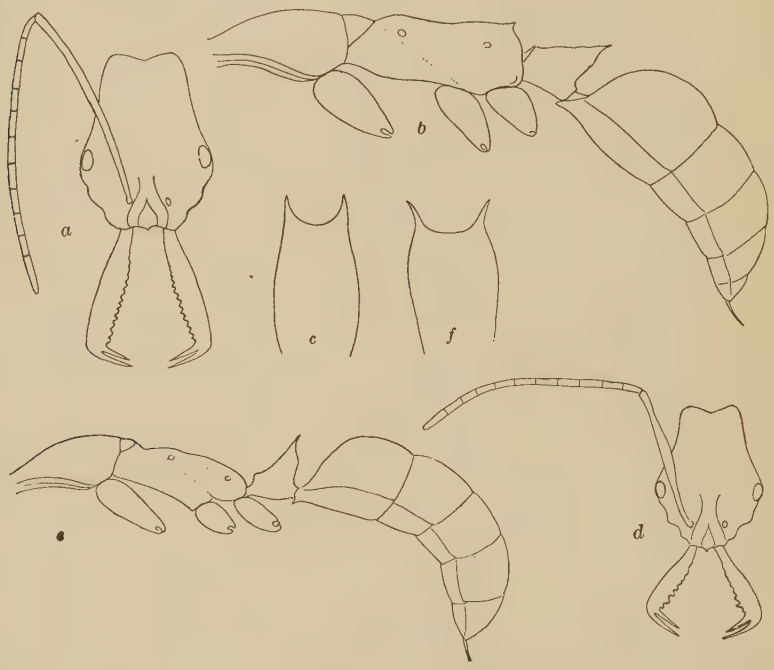

Fig. 6. a, head of *Anochetus* (*Stenomyrmex*) *emarginatus* (Fabr.) subsp. from Brazil, from above; b, body of same in profile; c, petiole of same from behind; d, head of *A.* (*S.*) *haytianus* sp. nov.; e, body of same in profile; f, petiole of same from behind.

Described from a number of specimens taken at Manneville and in the mountains north of Jacmel from small colonies nesting under stones in shady places.

This form is more than a mere subspecies of *emarginatus*, as all the various described subspecies of that form agree very closely with one another in their morphological characters.

13. **Odontomachus hæmatoda** *L.*

Formica hæmatoda Linné, Syst. Nat. Ed. X, 1758, p. 582, ☿ .

This typical, large, dark form of the species is recorded by Forel from Port au Prince (Mitth. Naturh. Mus. Hamb., XXIV, 1907, Beiheft, p. 1, ☿ ♀).

A male and two small workers taken by the junior author at St. Marc and three workers from Manneville are referable to this form, which has 15–18 subequal denticles on the inner mandibular border.

14. **Odontomachus hæmatoda** *L.* var. **paucidens** *Emery.*

Ann. Soc. Ent. France, LXII, 1893, p. 91, *nota*, ♀.

The types of this variety came from Haiti, and it has also been recorded by Forel from St. Marc and Cape Haitien (Mitth. Naturh. Mus. Hamb., XXIV, 1907, Beiheft, p. 1, ♀). It has the same sculpture and color as the typical form but the mandibles are shorter and have only 10–12 denticles on the inner mandibular border and the subapical teeth are large. We refer to this form a large number of specimens taken at Grand Rivière, Manneville, Furcy, Ennery, Diquini, Port au Prince, Petionville, and the mountains north of Jacmel.

15. **Odontomachus hæmatoda** *L.* subsp. **insularis** *Guérin.*

O. insularis Guérin, Icon. Règne Animal. Ins., VII, 1845, p. 423, ♀.

This subspecies, which is common in Cuba, Florida and Georgia, has been recorded from Haiti by Emery, but is not represented among the specimens taken by the junior author.

Subfamily Myrmicinæ.

16. **Pseudomyrma flavidula** *F. Smith* var. **delicatula** *Forel.*

Ps. delicatula Forel, Biol. Centr. Amer., 1899–1900, p. 93, ♀ ♀.

Several workers from Cape Haitien and Port au Prince. In the latter locality a nest was found in a twig in the courtyard of the American Legation.

17. **Pseudomyrma championi** *Forel* subsp. **haytiana** *Forel.*

Ann. Soc. Ent. Belg., XLV, 1901, p. 342, ♀; Mitth. Naturh. Mus. Hamb., XXIV, 1907, Beiheft, p. 7.

The color of the worker of this variety is described by Forel as the same as that of the typical form, "but the antennæ are rather bright yellow and the legs blackish brown, with the tarsi and articulations yellowish. The second node of the pedicel has reddish spots. Another reddish spot is found

on each side behind the eye. The red of the thorax and first joint of the pedicel is quite as bright, though more opaque; there is a brown spot on the mesonotum and another on the declivity of the metanotum." The type specimens were received by Forel from Father Jerome Schmitt with the locality "Haiti." Other specimens were later received from Keitel who took them at Port au Prince. None of the specimens before us agrees closely with Forel's description of *haytiana.* They all seem to belong to two varieties which may be described as follows:

18. **Pseudomyrma championi** *Forel* subsp. **haytiana** *Forel* var. **affinis** var. nov.

The worker has the entire head, except its anterior border, black. The mesonotum has a black spot as described by Forel for the typical *haytiana,* but the epinotum has a narrow black streak down its middle and is somewhat infuscated on the sides. The petiole and postpetiole are black or dark brown, the former yellow at the base. The fore tibiæ are often entirely reddish yellow.

The female (deälated) measures 8 mm. and has the thorax, petiole and postpetiole reddish yellow, with a large black spot on the mesonotum, a smaller one on the scutellum, a black streak on the middle of the epinotum, two minute dusky spots on each side of the post-petiole and two small spots on the petiolar node.

Specimens of this variety were taken from several colonies in twigs at Diquini and Petionville. The female is from the former locality.

19. **Pseudomyrma championi** *Forel* subsp. **haytiana** *Forel* var. **torquata** var. nov.

The worker differs from that of the preceding form in having the petiole, postpetiole and thorax black, except the pronotum, which is yellowish red.

Numerous workers from Grande Rivière and Cape Haitien.

20. **Pseudomyrma elongata** *Mayr* var. **cubaënsis** *Forel.*

Mitth. Naturh. Mus. Hamb., XXIV, 1907, Beiheft, p. 7, ♀ .

Several workers taken from hollow twigs at Grande Rivière and the mountains north of Jacmel closely resemble this common Cuban variety in their small size and the structure of the antennæ, head, petiole and thorax. This same variety is recorded by Forel from Cape Haitien (C. Gagzo).

21. **Pseudomyrma elongata** *Mayr* subsp. **subatra** subsp. nov.

Worker. Length 4–4.5 mm.

Differing from the typical *elongata* and the preceding variety in having the head somewhat shorter, the base of the epinotum shorter, more convex, and more rounded, so that it passes into the declivity with a much less distinct angle. The petiole and postpetiole are somewhat more slender, the former narrower behind, the latter slightly longer than broad. The surface of the body, behind the anterior portion of the head, much more shining, the punctures distinct but finer than in the other forms of *elongata* and the color much darker, being black, with the anterior portion of the head dark brown and the mandibles, clypeus and antennæ paler brown. The legs, including the tarsi, are black throughout.

Described from several workers taken at Diquini in the stems of bamboo. These specimens may represent a distinct species, but for the present we deem it best to regard them as having merely subspecific rank.

22. **Monomorium salomonis** *L.*

Formica salomonis Linné, Syst. Nat. ed 10, I, 1758, p. 580, ☿ .

Several workers and a deälated female of this well-known north African species were taken at Manneville from a large colony nesting beneath a stone in a very dry locality. The senior author has recorded it also from Nassau, New Providence Island, Bahamas. It has evidently been introduced into the West Indies by commerce, but seems to be spreading very slowly.

23. **Monomorium floricola** *Jerdon.*

Atta floricola Jerdon, Madras Journ. Lit. and Sci., XVII, 1851, p. 107, ☿ .

Several workers and females from Petionville.

24. **Monomorium carbonarium** *F. Smith* subsp. **ebeninum** *Forel.*

Monomorium carbonarium Forel, Mitth. Münch Ent. Ver., V, 1881, p. 8, ☿ .

Numerous workers and a female from Diquini, Manneville and Petionville.

25. **Cardiocondyla venustula** *Wheeler.*

Bull. Amer. Mus. Nat. Hist., XXIV, 1908, p. 128, ☿ ♀.

A single deälated female from the mountains north of Jacmel agrees very closely with the type female taken at San Juan, Porto Rico.

26. **Solenopsis geminata** *Fabr.*

Atta geminata Fabricius, Syst. Piez., 1804, p. 423, ♀.

Numerous workers of all sizes, together with males and females taken at Furcy, Cape Haitien, Manneville, and Diquini by the junior author and three workers taken in the San Francisco Mountains, San Domingo by Mr. Aug. Busck are all paler and more reddish than the common form in Cuba, Porto Rico and Jamaica and may represent a distinct variety. The species is also recorded from Port au Prince by Forel.

27. **Solenopsis globularia** *F. Smith.*

Myrmica (*Monomorium*) *globularia* F. Smith, Catalog. Hymen. Brit. Mus., VI, 1858, p. 131, ☿ ♀ ♂.

Recorded by Forel from Port au Prince.

28. **Solenopsis globularia** *F. Smith* var. **borinquenensis** *Wheeler.*

Bull. Amer. Mus. Nat. Hist., XXIV, 1908, p. 131, ☿.

Six workers from Manneville agree very closely with the types of this variety from Culebra Island.

29. **Solenopsis pollux** *Forel.*

Trans. Ent. Soc. London, 1893, p. 393, ☿ ♀ ♂.

Several workers from Cape Haitien and Manneville.

30. **Solenopsis inermiceps** sp. nov. (Fig. 7.)

Worker. Length nearly 2 mm.

Allied to *S. sulfurea* Roger. Head about $1\frac{1}{3}$ times as long as broad, subrectangular, with feebly convex sides and feebly and broadly excised posterior border. Eyes minute, at the anterior third of the head. Clypeus moderately convex, with broadly rounded anterior border, without longitudinal carinae or traces of teeth. Antennal scapes fully $\frac{2}{3}$ as long as the head; club large, as long as the remainder of the funiculus, its last joint 3 times as long as the penultimate; joints 3–7 slightly broader than long, first joint nearly as long as the four succeeding joints together. Mandibles oblique, with short teeth. Pro- and mesonotum robust, twice as long as the epinotum and $1\frac{1}{2}$ times as long as broad, moderately convex above and on the sides, separated from the epinotum by a strong suture and feeble impression. Epinotum small, a little longer than broad, its surface in profile sloping and feebly convex, without distinct base and declivity. Petiole with a slightly transverse, rounded node, which is a little narrower and higher than the postpetiole, with a small acute anteroventral tooth on the

peduncle. Postpetiole slightly broader than long, rounded. Gaster elongate elliptical, slightly narrowed in front. Legs rather slender.

Smooth and shining; the piligerous punctures scattered and extremely minute.

Hairs yellowish, erect, very sparse on the body; on the appendages shorter, denser and appressed.

Reddish yellow; head and thorax a little darker than the pedicel, gaster and appendages.

Fig. 7. *Solenopsis inermiceps* sp. nov. a, head of worker from above; b, profile of thorax and pedicel of worker.

Described from three workers taken at Petionville. A single specimen from Grande Rivière evidently belongs to the same species but is somewhat smaller (1.5 mm.). *S. inermiceps* is apparently very close to Roger's *S. sulfurea*, which was inadequately described. Emery has examined a cotype, however, and has figured the head (Bull. Soc. Ent. Ital., XXXVII, 1905, p. 136, fig. 17), which differs from that of *inermiceps* in having carinæ and very small teeth on the clypeus, in the outline of the head and the somewhat longer antennal scapes.

31. **Crematogaster victima** *F. Smith* var. **steinheili** *Forel.*

Cremastogaster steinheili, Mitth. Münch. Ent. Ver., V, 1881, p. 15, ♀.

Several workers and a deälated female from Manneville and Port au Prince agree very closely with specimens of this variety from Kingston Jamaica, except in having the gaster somewhat darker brown.

32. **Pheidole fallax** *Mayr* subsp. **jelskii** *Mayr.*

Pheldole jelskii, Horæ Soc. Ent. Ross., XVIII, 1884, p. 34, ♀♀.

Recorded from Port au Prince by Forel.

33. **Pheidole fallax** *Mayr* subsp. **jelskii** Mayr var. **antillensis** *Forel.*

Ph. jelskii var. *antillensis* Forel, Ann. Soc. Ent. Belg., XLV, 1901, p. 365, ♀♀

All the specimens, comprising soldiers, workers and males, taken at Diquini, St. Marc, Grande Rivière, Manneville, Port au Prince and in the

mountains north of Jacmel, are properly referable to this variety, which is very common, nesting in the ground, usually in open, dry localities. Several large colonies were nesting in the courtyard of the American Legation at Port au Prince.

34. **Pheidole megacephala** *Fabricius.*

Formica megacephala Fabricius, Ent. Syst., II, 1793, p. 361, ♀.

Soldiers, workers and deälated females from Furcy, Milot and Diquini.

35. **Pheidole terresi** sp. nov.

Soldier: Length 2.3–2.6 mm.

Allied to *Ph. floridana* Emery. Head a little longer than broad, as broad in front as behind, with feebly convex sides, rather angular posterior corners and rather deeply and angularly excised posterior border. Occipital groove rather deep behind but disappearing anteriorly in the middle of the head, which is convex. Antennal sulci very feebly developed. Eyes rather small, at the anterior third of the head. Mandibles convex, with two apical teeth. Mentum with two prominent, acute teeth at its anterior border. Clypeus short, rather depressed, its anterior border feebly bidentate in the middle. Antennæ slender, scapes as long as half the distance from their insertions to the posterior corners of the head, joints 2–8 of the funiculus subequal, as long as broad, club as long as the remainder of the funiculus. Thorax robust, the pronotum nearly half as broad as the head, with prominent, angular humeri, separated by a distinct suture from the mesonotum which is small, abruptly sloping and with a transverse swelling. Mesoëpinotal constriction deep. Epinotum small and short, not longer than broad, in profile with the base a little shorter than the declivity, bearing two small, acute, erect teeth, which are decidedly shorter than their distance apart at the base. Petiole about 1½ times as long as broad, with small but prominent anterior angles when seen from above broadest behind through the node, which is compressed anteroposteriorly, rather acute at the summit in profile and with its upper margin rather deeply notched when seen from behind. Postpetiole broader than long, somewhat broader than the petiole, with a very short, acute conule on each side a little in front of the middle. Gaster about as large as the head. Legs rather long, the femora and tibiæ not conspicuously swollen.

Shining throughout. Mandibles with coarse, scattered punctures. Clypeus smooth in the middle, longitudinally rugose on the sides. Head sharply longitudinally rugose on its anterior half, the interrugal spaces neither reticulate nor punctate and the rugæ absent behind on the antennal sulci, which are smooth and shining and not sharply defined laterally. Anteriorly these sulci are crossed by concentric rugæ running from the sides of the head to the frontal carinæ. The frontal rugæ diverge posteriorly and extend somewhat further back than those on the cheeks. The posterior portion of the head is glabrous, except for small, scattered, piligerous punctures. Thorax smooth, except the epinotum, which is subopaque, finely and rather superficially punctate-rugulose; pedicel, gaster, and legs smooth and shining, with fine, very sparse, piligerous punctures.

Hairs yellow, rather delicate, sparse, erect or suberect on the body, and anterior surfaces of the antennal scapes, a little shorter and more reclinate on the legs.

Mandibles, head, thorax and pedicel reddish yellow, remainder of body paler; borders of mandibles and clypeus broadly blackish or deep red.

Worker. Length 1–1.3 mm.

Closely resembling the soldier except in the head, which is small, smooth and shining and without rugæ, even on its anterior portion and cheeks. Antennal scapes extending a little beyond the posterior corners of the head. Pronotum longer and narrower and with rounded sides, not produced in the humeral region. Petiolar node with entire, rounded superior border, postpetiole as long as broad, rounded above and on the sides. Pilosity like that of the soldier but shorter and sparser. Color pale yellow throughout, except the borders of the mandibles and clypeus which are brownish.

Female (deälated). Length 4–4.5 mm.

Resembling the soldier. The head is broader and more nearly square, with rather straight sides and much less deeply excised posterior border. The rugæ are stronger and carried back nearly to the posterior corners. In other respects like the soldier, except for the usual morphological differences. The gaster is reddish yellow like the remainder of the body and the pilosity is somewhat more conspicuous. The wing insertions and thoracic sutures are blackish or dark brown.

Described from several soldiers and workers and two females taken from small colonies nesting in the ground in clay soil at Diquini and Milot.

This species belongs to the perplexing group of small neotropical forms including *Ph. floridana* Emery, *flavens* Roger, *anastasii* Emery, *punctatissima* Mayr, *goeldii* Forel and *mærens* Wheeler, but differs from all of these at first sight in having the worker smooth and shining and not opaque and finely punctate. In this respect it resembles *Ph. dimidiata* Emery and *orbica* Forel, but differs from the former in the shape of the postpetiole, sculpture of the head, color, etc., from the latter in the longer antennal scapes, very different sculpture and color and very different pronotum, which is much broader and has much more prominent, angular humeri. The teeth on the epinotum are also much smaller and more acute than in *orbica*.

36. **Pheidole terresi** var. **illota** var. nov.

Soldier. Differing from the soldier of the typical *terresi* merely in having the dorsal surface more or less infuscated, the deeper color on the head being confined to the front, vertex and posterior corners.

Worker. Much darker than the soldier, the body being piceous or even blackish, with the mandibles, antennæ and legs yellow, the clypeus light brown.

Described from several soldiers and workers taken in the mountains north of Jacmel and at Furcy.

37. **Pheidole flavens** *Roger* var. **haytiana** *Forel.*

Mitth. Naturh. Mus. Hamb., XXIV, 1907, Beiheft, p. 6, ☿.

Soldier. Length 2.4–2.6 mm.

Differing from the soldier of the typical *flavens* Rog. of Cuba and the vars. *thomensis* Emery of St. Thomas and *vincentensis* Forel of St. Vincent in its sculpture, much darker color and in the shape of the epinotum. The latter has the base distinctly shorter than the declivity in profile. The head is more opaque and the longitudinal rugæ run back till they leave only the posterior fourth of the head smooth and shining, and the punctures and reticulation between the rugæ, especially on the antennal sulci, are more distinct. The head and pronotum are dull ferruginous, the remainder of the body dark brown or blackish, the antennal scapes and the femora more or less infuscated.

Worker. Length 1.5 mm.

Head and thorax dark brown or black; pedicel and gaster a little paler; antennæ, mandibles and legs yellow, the femora more or less infuscated in the middle. The base of the epinotum in profile is distinctly shorter than the declivity.

Female. Length 3.3–3.7 mm.

Thorax, pedicel and gaster black; head, including the mandibles, deep ferruginous, sometimes blackish behind. Antennæ and legs colored as in the soldier. Wings grayish hyaline, with pale brown veins and stigma.

Male. Length 3 mm.

Head blackish; thorax brown; remainder of body, including the sutures of the thorax, the antennæ, clypeus, mandibles and legs sordid yellow. Wings as in the female.

Described from numerous specimens taken from several colonies in the following localities: Petionville, Manneville, Diquini, and Grande Rivière. The nests are usually under bark. Forel has described only the worker of this variety from Port au Prince.

38. **Pheidole flavens** *Roger* var. **vincentensis** *Forel.*

Trans. Ent. Soc. London, 1893, pp. 411, ☿ ♀ ☿ ♂.

Several soldiers, workers and a single deälated female from Port au Prince, St. Marc, Grande Rivière and Petionville represent either this or a very closely allied variety of *flavens*. The soldiers and workers agree rather closely with cotypes of *vincentensis* Forel in the senior author's collection, except that the gaster in both phases is darker and in the female quite black. The Haitian specimens may, perhaps, be more properly regarded as representing a transition between the vars. *haytiana* and *vincentensis*.

39. **Pheidole punctatissima** *Mayr* var. **jamaicensis** *Wheeler.*

Several soldiers and workers and a single deälated female from Petionville. The female measures nearly 4.5 mm. and is black, with the antennæ,

mandibles, clypeus, front and cheeks ferruginous and the legs yellow, except the middle portions of the femora, which are black. The mesonotum is opaque and finely longitudinally rugose, with a median line and the parapsidal sutures smooth and shining.

40. **Pheidole mœrens** *Wheeler* subsp. **creola** subsp. nov.

Soldier. Length 2.3–2.5 mm.

Differing from the typical *mœrens* in the following particulars: the sculpture of the head is more extensive, leaving only the posterior corners shining. The longitudinal rugæ cover about ⅔ of the head and behind them the surface is densely punctate, except the posterior corners which have only a few elongate, coarse punctures. The thorax is opaque and densely punctate throughout, the petiole and postpetiole punctate on the sides, with smooth and shining nodes. The color of the body is much darker, being black, with the antennæ, mandibles and clypeus, except their borders, red, the legs yellow, with the middle portions of the femora blackened, as are also the scapes.

Worker. Length 1–1.3 mm.

Closely resembling the worker of the typical *mœrens*, except in color, the pedicel and gaster being black, like the head and thorax, and the femora infuscated.

Described from several specimens taken at Diquini and in the mountains north of Jacmel. In the typical *mœrens* and in the var. *dominicensis* Wheeler from Dominica, the sculpture of the pronotum in the soldier is transversely rugulose above and the punctuation is more superficial and less regular. *Ph. mœrens* is undoubtedly very closely related to *flavens*, and when this and the allied species have been more closely studied may prove to have only subspecific rank.

41. **Aphænogaster relicta** sp. nov. (Fig. 8*c*.)

Worker. Length 4–5 mm.

Head about 1½ times as long as broad, a little broader in front than behind, where it is rounded and without distinct posterior corners, but with a distinct occipital margin which is somewhat elevated on each side at the posterior end of the gula. Eyes moderately large and convex, just in front of the middle of the sides of the head. Mandibles rather large, with the external borders straight at the base, more convex at the tips; their apical borders with 6 or 7 teeth, those near the base being short and broad. Clypeus moderately convex in the middle, depressed on the sides, its anterior border somewhat projecting, with a narrow but distinct notch in the middle. Frontal carinæ elevated and rounded in front, lower, more approximated and subparallel behind. Antennæ rather stout, the scapes reaching fully twice their greatest diameter beyond the posterior border of the head, at the base with a compressed, rounded lobe, not unlike that on the scapes of *Myrmica scabrinodis;* funicular joints, except the last, subequal, about 1½ times as long as broad. Thorax long and robust, pro- and mesonotum narrower than the head, in profile hemispherical; seen from above

the pronotum is rather angular in front just behind the neck and more convex on the sides, behind. Mesoëpinotal constriction deep and rather narrow Epinotum longer than high, its base in profile rather convex in front, more flattened behind, twice as long as the rather sloping declivity, armed with two powerful, acute spines, which are nearly as long as the base of the epinotum, directed backward, upward and outward and slightly curved downward. Petiole from above about twice as long as broad, broadest behind, with slightly concave sides; node in profile with a longer, slightly concave anterior and a shorter, convex posterior declivity and a rather acute summit; seen from behind its border is rounded and entire. Postpetiole as long as broad, broadest behind, where it is half again as broad as the petiolar node, rounded in profile above and swollen ventrally at its anterior end. Gaster broadly elliptical. Legs long and rather stout.

Mandibles subopaque, densely and coarsely striated. Clypeus, head and thorax subopaque, very coarsely, reticulately rugose, the rugæ on the head somewhat finer than those on the thorax and with a more longitudinal trend. Epinotal spines

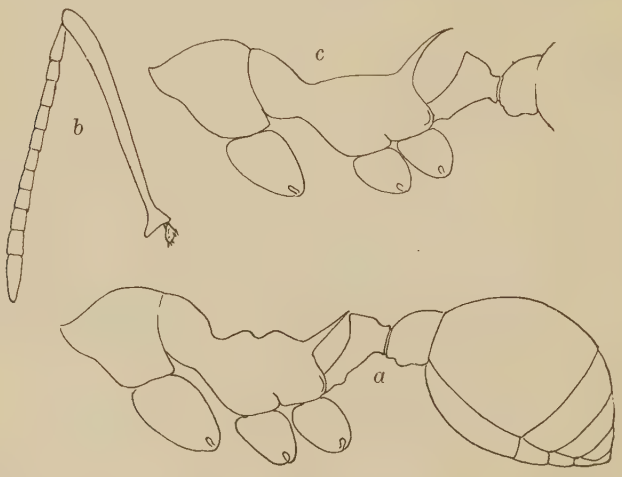

Fig. 8. *Aphænogaster relicta* sp. nov. and *A. relicta* subsp. *epinotalis* subsp. nov. Worker. a, profile of body of subsp. *epinotalis;* b, antenna of subsp. *epinotalis;* c, profile of thorax and pedicel of *A. relicta.*

shining at their tips, finely longitudinally striated at the base; epinotal declivity transversely rugulose. Neck of pronotum, petiole, postpetiole, basal and middorsal portion of first gastric segment, scapes and legs, opaque, densely and evenly punctate, with much sparser, evenly distributed and coarser piligerous punctures. Sides of first segment and the whole of the remaining gastric segments smoother, more sparsely punctate and more or less shining. Antennal funiculi rather shining.

Hairs glistening white; coarse, pointed, erect, rather long, moderately abundant, covering the body and appendages, shorter and more reclinate on the scapes and tibiæ.

Deep black; mandibles, except their bases and borders, tarsi, articulations of legs, two large spots on the base of the gaster and the upper surface of the postpetiole, dull red. In some specimens the two gastric spots are fused into one and in others the entire gaster and postpetiole are black.

Female (deälated). Length nearly 6 mm.

Differing from the worker in the shape of the thorax. The mesonotum is only moderately, the scutellum very convex and protuberant, the base of the epinotum long, slightly sloping and straight in profile, with the spines much stouter, less divergent and shorter than in the worker, being shorter than the distance between their bases. The rugosity of the thorax is somewhat finer than in the worker and the mesopleuræ are densely punctate. The sculpture of the remainder of the body, the pilosity and color are like those of the worker.

Male. Length 4 mm.

Head through the eyes about as long as broad, produced backward and somewhat conical behind. Cheeks moderately short. Mandibles feeble, but distinctly denticulate. Anterior border of clypeus broadly rounded and entire. Antennæ slender; scapes about 5 times as long as broad, first funicular joint slightly swollen, about twice as long as broad, increasing in length towards the tip. Thorax robust, the anterior portion of the pronotum projecting forward, convex, flattened behind; epinotum unarmed, sloping, without distinct base and declivity. Petiole, postpetiole and gaster similar to those of the worker.

Head, thorax, pedicel and basal half of first gastric segment opaque, densely punctate, remainder of gaster and legs shining and more superficially punctate. Mesonotum with a smooth, shining median longitudinal line.

Pilosity very similar to that of the worker.

Black; mandibles and genitalia yellow; clypeus and antennæ brown; legs piceous; wings faintly infuscated, with pale veins and stigma.

This beautiful species, the first *Aphænogaster* to be found in the West Indies, is described from numerous workers, a single female and a single male taken from several colonies at Diquini, Petionville, Port au Prince and in the mountains north of Jacmel. It nests in the earth in holes beneath stones in moist localities, usually on hill-sides. The workers are timid and very rapid in their movements. They are quite unlike the workers of any of our other North American species of *Aphænogaster* in the shape of the antennal scapes, in sculpture and coloration. The species is probably an ancient insular relict, confined to the island of Haiti.

42. **Aphænogaster relicta** subsp. **epinotalis** subsp. nov. (Fig. 8*a* and *b*.)

Worker. Differs from the typical form in having the base of the epinotum shorter and with a median transverse impression in the middle, very distinct in profile; the epinotal spines are shorter, straight and distinctly less erect and the red on the postpetiole and gaster is duller.

Described from a series of specimens taken at Manneville.

43. **Pogonomyrmex (Ephebomyrmex) schmitti** *Forel.* (Fig. 9.)

Pogonomyrmex schmitti Forel, Ann. Soc. Ent. Belg., XLV, 1901, p. 339, ☿ .
Pogonomyrmex (Ephebomyrmex) schmitti Wheeler, Psyche, 1902, p. 390, ☿ .
Worker. Length 3.5–4 mm.

Head subrectangular, a little longer than broad, as broad in front as behind, with rather straight sides and feebly excised posterior border. Mandibles convex, with 6 subequal teeth. Clypeus short, convex; its anterior border entire and broadly rounded. Frontal area elongate, triangular. Antennæ rather stout, their scapes not reaching to the posterior border of the head; joints 2–7 of the funiculi somewhat broader than long. Thorax short and broad, but little longer than the head, with the mandibles, including the neck nearly twice as long as broad, evenly convex above in profile, without promesonotal and mesoëpinotal sutures. Epinotum sloping, its base and declivity subequal, bearing two short, stout spines, which are directed backward, upward and outward and are longer than broad at their bases and shorter than their distance apart. Metasterna prolonged upward and backward into a pair of similar but somewhat shorter spines, which are slightly curved forward. Petiole from above fully twice as long as broad, with a slender peduncle occupying half its length and provided with a stout, triangular tooth on its ventral surface. The node, which is as broad as half the length of the whole segment, when seen in profile has a straight anterior surface rising at a right angle from the peduncle and half as long as the sloping posterior surface. The two surfaces meet at a sharp ridge, which, seen from above, forms the broadly rounded anterior margin of the node; its sides are straight and converge posteriorly to the postpetiole, which is broader than the petiole, a little broader than long, campanulate and provided with a large swelling on its anteroventral surface. Gaster slender, elongate-elliptical, with a powerful sting. Legs long and stout.

Fig. 9. *Pogonomyrmex* (*Ephebomyrmex*) *schmitti* Forel. Worker, a, profile of thorax and pedicel; b, head from above.

Mandibles and head opaque, the former and the clypeus rather finely and regularly longitudinally rugose, the head somewhat more coarsely, the rugæ with reticulate-punctate spaces between them and diverging somewhat from the median line on the posterior portion of the head. Thorax still more coarsely and somewhat more irregularly and reticulately, longitudinally rugose. Petiole, postpetiole and basal third or half of first gastric segment opaque and densely punctate the posterior surface of the petiolar node also longitudinally rugulose. Posterior portion of first gastric segment and the remaining segments shining, very superficially shagreened or reticulate, with small, sparse, piligerous punctures. Legs and scapes densely punctate, the former feebly shining, the latter opaque.

Hairs short, stiff, pointed, dark brown or blackish, moderately abundant, erect on the body, somewhat more reclinate on the legs and scapes. Gula without ammochætæ.

Black; mandibles, tip of gaster, tarsi beyond the first joint and sometimes also the peduncle of the petiole, the legs and clypeus (in immature specimens?), deep red.

Female (deälated). Length 5.5 mm.

Closely resembling the worker, but differing in the following characters. The rugæ on the mesonotum, scutellum and pleuræ are more regularly longitudinal and the epinotum and posterior surface of the petiolar node are coarsely reticulate-rugose. The epinotal spines are stouter and proportionally longer than the metasternal spines, and the gaster, though small, is proportionally broader than in the worker.

Described from numerous workers and a single female from Cape Haitien, Furcy, Petionville, Diquini, Port au Prince and the mountains north of Jacmel. These specimens all agree closely with Forel's description and with a cotype received by the senior author many years ago from Rev. P. J. Schmitt, O. S. B., to whom the species was dedicated. *P. schmitti* nests in the ground in crater nests, but sometimes also under stones. It is a harvesting ant like the other species of the genus, and like these is also fond of eating insects, for the junior author often saw workers carrying whole insects or fragments of them into the nest.

44. **Pogonomyrmex** (**Ephebomyrmex**) **schmitti** *Forel* var. **sublævigatus** var. nov.

The worker and female differ from those of the preceding form in having the postpetiole and base of the gaster smooth and shining like the remainder of the abdomen or with only traces of the fine punctures at the extreme base of the first segment.

This variety was taken at Manneville and Ennery.

45. **Pogonomyrmex** (**Ephebomyrmex**) **saucius** sp. nov. (Figs. 10 and 11.)

Worker. Length: 5–5.5 mm.

Head subrectangular, a little longer than broad, with straight sides and feebly excised posterior border and the eyes just in front of the middle of its sides. Mandibles with 6 subequal teeth and rather convex external borders. Clypeus with straight, entire anterior border and a blunt, tooth-like projection on its upper surface on each side near the lateral border. Frontal area small, elongate-triangular. Antennal scapes not reaching to the posterior corners of the head; joints 2–7 of the funiculi as broad as long. Thorax shaped as in *P. schmitti* and with similar spines on the epinotum and metasterna. Postpetiole, petiole and gaster also similar in structure, but the anterior surface of the petiolar node rises a little less abruptly from the peduncle and the posterior surface is more convex and, when seen from above, its anterior border is more pointed or acuminate in the middle.

Mandibles, head and thorax opaque. Mandibles striated; clypeus, head and thorax regularly longitudinally rugose, the interrugal spaces being finely and densely

punctate. On the cheeks the rugæ are rather far apart but are denser and diverge posteriorly on the posterodorsal portion of the head. The space enclosed by the four thoracic spines, is concave, smooth and shining. Petiole, postpetiole and gaster also smooth and shining, with small, sparse piligerous punctures, except the dorsal surface of the petiolar node, which is densely punctate and longitudinally rugose, the rugæ converging anteriorly to the apex of the node. Antennal scapes and legs finely shagreened, the former opaque, the latter somewhat shining.

Hairs dark brown, short, stiff, moderately abundant, erect on the body, somewhat more oblique on the scapes and legs. Gula without ammochætæ.

Brownish black; mandibles, except their teeth and borders, sides of clypeus, cheeks, antennæ, legs, thoracic spines, peduncle of petiole, anterior border and sides of postpetiole and a band across the anterior border of the first gastric segment, red. Tip of gaster and margins of posterior gastric segments narrowly yellowish.

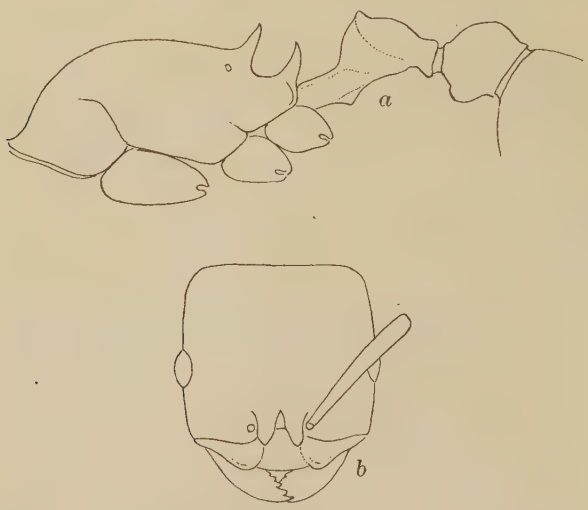

Fig. 10. *Pogonomyrmex* (*Ephebomyrmex*) *saucius* sp. nov. Worker. a, profile of thorax and pedicel; b, head from above.

Male. Length 4–4.5 mm.

Head slightly longer than broad, with large eyes and ocelli, narrowest through the cheeks, which are straight, rounded and broader behind the eyes. Mandibles like those of the worker but smaller. Clypeus convex, without lateral tooth-like projections. Antennal scapes scarcely four times as long as broad, somewhat curved and dilated at the base; first funicular joint a little longer than broad, second as long as the scape, joints 3–9 subequal, a little more than twice as long as broad; joints 10 and 11 shorter, terminal joint nearly as long as the two preceding together. Thorax robust, through the wing insertions as broad as the head. Mesonotum with well-marked Mayrian furrows, convex in front, flattened behind; epinotum and metasterna unarmed, the former rounded without distinct base and declivity. Petiole long; its node rounded in profile, constricted behind; its peduncle with a distinct ventral tooth. Postpetiole similar to that of the worker. Fore wing with a discal and two cubital cells.

Head, thorax and petiole opaque, finely and densely punctate, head and thorax also longitudinally rugulose above and on the sides of the epinotum. Mandibles, postpetiole and gaster shining, the mandibles coarsely and sparsely punctate and at the base finely striate. Legs rather shining, finely shagreened.

Pilosity similar to that of the worker.

Black; tips of mandibles, funiculi tibiæ, tarsi, bases and tips of femora, red; genitalia brown. Wings grayish hyaline, with brown veins and stigma.

Fig. 11. Desert at Manneville showing nesting site of *Pogonomyrmex* (*Ephebomyrmex*) *saucius* sp. nov. beneath stones in left foreground.

Described from numerous workers and two males taken from a couple of colonies nesting in the ground beneath stones along the very arid trail leading from Manneville to the Dominican border, about half a mile from the former place. Each of the nests contained a little heap of stored grain. The species is apparently restricted to this arid region, and no doubt ranges over the territory about Lake Assuei. It is a more timid ant than *P. schmitti,* from which species it is readily distinguished in the worker phase by its larger size, the different and more regular sculpture of the thorax, the tooth-like projections on the clypeus and the peculiar coloration.

46. **Macromischa sallei** (*Guérin.*)

Myrmica sallei Guérin, Rev. Mag. Zool. Pure et Appliq. (2), IV, 1852, p. 76, pl. iii, figs. 2–4; ☿ ♀ ♂.

Macromischa sallei Forel, Biol. Central. Amer., 1899–1900, p. 57, *nota,* ☿ ; Bull. Soc. Ent. Suisse, X, 1, p. 272.

Worker. Length about 5 mm.

Head subrectangular, a little longer than broad, with feebly convex sides, nearly straight posterior border, rounded posterior corners and convex eyes at the middle of the sides. Mandibles rather convex, with 4 or 5 subequal teeth. Antennæ slender, their scapes reaching somewhat beyond the posterior corners of the head; funicular joints all longer than broad, the three terminal ones largest and forming a club. Thorax longer than the head, including the mandibles, and narrower, broadest through the pronotum, which is somewhat flattened above and on the sides and separated from the mesonotum by a distinct suture and shallow constriction both dorsally and laterally Meso- and epinotum not separated by a constriction or suture, nearly as broad as the pronotum, longer than broad, with feebly convex lateral and dorsal surfaces. Epinotum bearing two straight spines, which are nearly as long as the dorsal surface of the meso- and epinotum, stout and close together at the base but rapidly tapering to acute tips, directed backward, rather strongly outward and slightly upward. Petiole nearly three times as long as broad, with a slender peduncle making up the anterior $\frac{2}{3}$ of its length and at the posterior third with an abrupt, rounded, slightly transverse node, which is much higher than the postpetiole. This is about half again as broad as the petiolar node, campanulate and somewhat narrower in front than behind. Gaster small, elliptical with a well-developed sting. Legs long; femora slender at the base, strongly incrassated just beyond the middle; tibiæ clavate, without spurs.

Head and thorax opaque; petiole, postpetiole and gaster shining. Head finely longitudinally rugose and punctate; thorax also longitudinally rugose, more coarsely and irregularly on its dorsal than on its pleural surface. Legs shining, sparsely punctate.

Hairs pale, whitish, coarse, long and suberect, covering the body and appendages, including the antennal funiculi.

Color ferruginous red; legs paler; gaster black, except in some specimens which have the base of the first segment ferruginous. Antennal funiculi infuscated.

Female. Length 7 mm.

Resembling the worker in color and sculpture, except that the borders of the ocelli, the scutellum and mesonotum are black and at least the basal third of the first gastric segment is ferruginous. The head is more elongate and elliptical and more rounded behind. Wings pale yellowish, with yellow veins and stigma. There is no discal and only one cubital cell.

Male. Somewhat less than 5 mm.

Head small, rounded behind. Eyes large and prominent. Mandibles small, pointed, less convex than in the worker, with finely dentate apical borders Antennæ slender, scapes half as long as the funiculi. Mesonotum with distinct Mayrian furrows. Epinotum unarmed. Petiole and postpetiole similar to those of the female, but the node of the former much lower, subconical and not transverse. Gaster small. Legs long and slender, scarcely incrassated. Venation of wings like that of female.

Color brown, passing into ferruginous on some parts of the body. Antennæ yellowish brown. Wings whitish, with yellow veins and stigma.

All three phases were taken by Auguste Sallé in April 1850 from arboreal nests in a large morass known as the Cienaga del Timbladero, near Rancho Arriba, on the River Nisae, in the heart of San Domingo.

The foregoing rather incomplete description is drawn from Guérin and from a single poorly preserved worker cotype (*ex* Coll. Saussure) presented

by Prof. Forel to the senior author. Guérin gives an excellent figure of the peculiar carton nest (pl. iii, fig. 1), which is very much like that of the following subspecies taken in Haiti.

47. **Macromischa sallei** (*Guérin*) subsp. **haytiana** subsp. nov. (Figs. 12, 13 and 14.)

Worker. Length 3.5–4.5 mm.

Closely resembling *M. sallei* in form, but somewhat smaller and more slender, and with the long epinotal spines less thickened at the base. Mandibles, clypeus

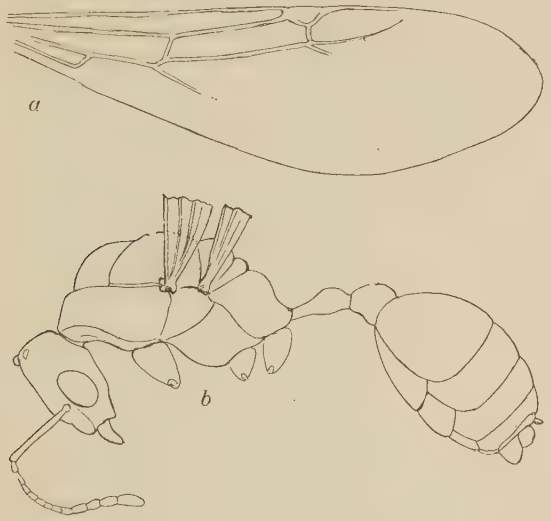

Fig. 12. *Macromischa sallei* (Guérin) subsp. *haytiana* subsp. nov. Male. a, wing; b, body in profile.

and frontal area slightly shining, longitudinally rugose; head opaque, densely and finely longitudinally rugulose-punctate. Thorax coarsely and somewhat vermiculately longitudinally rugose and somewhat shining; epinotal declivity irregularly and transversely rugulose. Petiole and postpetiole rugose on the sides and below, their nodes smooth and shining. Petiolar node fully as long as broad, not transverse. Gaster and legs shining, with sparse piligerous punctures; antennal scapes opaque.

Hairs white, coarse, moderately long and abundant, suberect, covering the body and appendages; pubescence absent.

Mandibles and head yellowish red; cheeks, sides and border of clypeus and borders of mandibles reddish brown. Thorax blackish red or dark purplish brown, pronotum often paler. Petiole, post-petiole, gaster, legs and antennæ black; tarsi beyond the first joint reddish.

Female (deälated). Length 6.5 mm.

FIG. 13. View at Furcy. Home of *Macromischa sallei* Guérin subsp. *haytiana* subsp. nov.

Closely resembling the worker in form and color. The rugæ on the head are sharper, those on the thorax much finer and more regular, and those on the sides of the petiole and postpetiole more distinct.

Male. Length: 4–4.3 mm.

Mandibles smooth, scarcely shining; head opaque, finely punctate; the clypeus and dorsal surface also longitudinally rugulose. Thorax, petiole and postpetiole subopaque, the surface of the thorax irregularly, that of the epinotum transversely rugose. This portion of the thorax is unarmed, convex and sloping, without distinct base and declivity. Petiole with a very low node. Postpetiole and gaster similar to those of the worker. Legs long and slender, without incrassated femora and tibiæ.

Pilosity similar to that of the worker.

Black; mandibles, antennae and tarsi yellow; clypeus, frontal area and three large spots on the mesonotum red. Femora and tibiæ piceous or black. Wings whitish hyaline, with pale yellow veins and stigma.

Described from numerous workers and males and a single female taken from several carton nests at Furcy in a locality represented in the accompanying figure (Fig. 13). The typical *M. sallei* is described by Guérin as nesting in trees in marshy places, but the subsp. *haytiana* lives on bushes in the mountains in regions which are never flooded. Both forms are extremely abundant in the restricted localities in which they occur and form very populous colonies, unlike most species of *Macromischa*. Along the ridge at Furcy the junior author observed hundreds of nests of *haytiana*, usually built in a peculiar shrub which is the most abundant and typical plant of the region. This shrub, which has very dense, short leaves and extra-nuptial nectaries, has been kindly identified for us by Prof. Robinson of the Gray Herbarium as *Baccharis myrsinites* (Lam.) Pers. The matted foliage produced by the numerous stems and densely leaved branches of this shrub afford the ants shade and concealment. Occasionally nests were also observed in other trees, especially in the smaller pines and among the plants of the small coffee plantations. The nest varies in diameter from about 1 to 6 or 7 inches, and also in shape, though it is always more or less oval or elliptical, at least when fully developed. The smaller nests are built around the stem of the plant, in such a manner as to embrace in their substance the insertions of the branches. At first sight the carton of which these structures consist, resembles that of certain species of *Azteca* and *Crematogaster*, but it seems to consist of finely shredded grass, which is afterwards cemented together and covered with true carton. Additions are made to the nest in this manner and some are often found consisting of carton throughout, excepting an envelope of the fine fibres, which may or may not cover the whole surface. Occasionally one may find a nest consisting of the fibrous material throughout. As none of the latter variety contained larvæ or pupæ, they are probably to be regarded as tents or pavilions erected as shelters over the extrafloral nectaries of the plants.

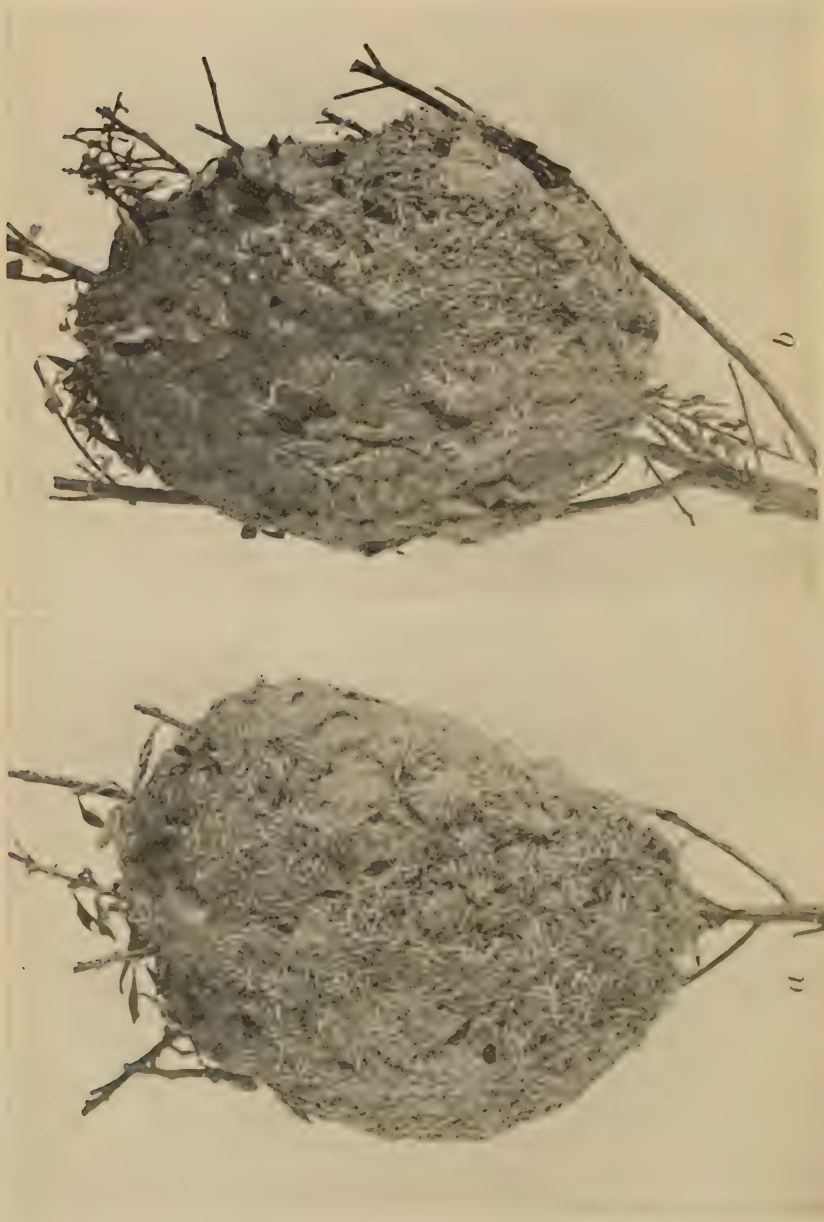

Fig. 14. Nests of *Macromischa sallei* (Guérin) subsp. *haytiana* subsp. nov.

M. haytiana is diurnal in habit. It is evidently omnivorous, as it was seen attending Aphids and Membracids and the nectaries of the plants, and as its nests contained pieces of insects, mostly Orthoptera, and some objects which seemed to be plant seeds. In one nest a living Membracid nymph was found. The workers are pugnacious and sting severely. When the nest is disturbed they rush forth and scatter over all parts of the bush, and while moving about carry the gaster bent down beneath the thorax with the sting directed forward, a habit which is permitted by the great length of the petiole. This same habit has also been observed by the senior author in some of the other species of the genus (*M. splendens* Wheeler of the Bahamas and *M. isabellæ* Wheeler of Porto Rico).

48. **Macromischa flavidula** sp. nov. (Fig. 15.)

Worker. Length 1.5–1.7 mm.

Head somewhat longer than broad, as broad in front as behind, with evenly convex sides, nearly straight posterior border, rounded posterior corners and the moderately convex eyes at the middle of the sides. Mandibles with rather straight external and finely denticulate apical borders. Clypeus convex, with broadly rounded anterior border. Frontal carinæ subparallel; frontal area indistinct. Antennal scapes reaching to the posterior border of the head; club of funiculus large, 3-jointed; remaining joints, except the first, small, broader than long. Thorax short, about as long as the head with the mandibles, a little broader in front than behind, in profile with evenly rounded, convex dorsum, without any traces of promesonotal or mesoëpinotal sutures; humeri rounded, epinotum sloping, without distinct base and declivity, bearing two spines which are longer than the declivity and much longer than their distance apart, curved downward and directed backward and outward. Petiole with a short, slender peduncle, bearing a small, acute tooth on its ventral surface, and a node which is longer than broad, with its anterior declivity in profile sloping and slightly concave, its summit slightly flattened and its posterior declivity very short and convex. Postpetiole large, broader than long, three times as broad as the petiole behind, in profile rounded and convex above. Gaster small, at the base only a little broader than the postpetiole. Legs rather short; femora slightly incrassated.

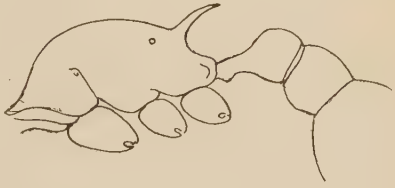

Fig. 15. *Macromischa flavidula* sp. nov. Profile of thorax and pedicel of worker.

Whole surface of body very smooth and shining.

Hairs white, blunt, short, scattered and erect on the body, very minute and appressed on the scapes and legs.

Yellow; mandibles, antennæ, epinotal spines, legs and venter paler and more whitish.

Female (deälated). Length: 3.3 mm.

Differing from the worker in the following characters: The head is subcircular, not longer than broad, with more convex sides. The epinotal spines are shorter and stouter and not curved, the upper surface of the mesonotum is flattened and the gaster is large and elongate elliptical, the postpetiole even broader in proportion to its length. The wing insertions, a spot on the scutellum, a broad band across the first gastric segment and a much narrower band near the posterior border of each of the following segments are brown.

Described from three workers and a female taken from a single nest in the ground under a stone at Manneville. This is the smallest known species of *Macromischa* and differs also from the other members of the genus in color and sculpture, though it is morphologically closely related to a group of small species embracing *M. subditiva* Wheeler of Texas, *albispina* Wheeler of Culebra Island and *lævissima* Wheeler of Mexico.

49. **Tetramorium guineense** *Fabricius.*

Formica guineensis Fabricius, Ent. Syst., II, 1793, p. 357, ☿ .

Several workers and females from Diquini, Grande Rivière, Manneville, Momance and Ennery. This tropicopolitan ant must have been introduced into the island more than 60 years ago, as it is cited from San Domingo by Guérin (Rev. Mag. Zool. (2) 1852, p. 79).

50. **Tetramorium (Tetrogmus) simillimum** *F. Smith.*

Myrmica simillima F. Smith, List Brit. Anim. Brit. Mus., VI, 1851, p. 118, ☿ .

Numerous workers and females from Diquini, the mountains north of Jacmel, Manneville and Grande Rivière. Like the preceding this is a well-known tramp species which originated in the Old World tropics.

51. **Wasmannia auropunctata** *Roger.*

Tetramorium ? *auropunctatum* Roger, Berl. Ent. Zeitschr., VII, 1863, p. 182, ☿ ♀ ♂.

Numerous workers and deälated females from Diquini, Milot, Ennery, Grande Rivière, Petionville, and the mountains north of Jacmel. This species is widely distributed through the West Indies, Mexico and Central America.

52. **Cryptocerus hæmorrhoidalis** *Latreille.* (Fig. 16.)

Latreille, Hist. nat. Fourm., 1802, p. 276, ☿ .

Cryptocerus hamulus Roger, Berl. Ent. Zeitschr., VII, 1863, p. 209, ☿ .

Cryptocerus hamulus Roger var. *haytianus* Forel, Ann. Soc., Ent. Belg., XLV, 1901, p. 337, ☿ .

Comparison of the descriptions of Latreille, Roger and Forel and a cotype of the var. *haytianus* received from Rev. P. J. Schmitt with a large series of workers taken by the junior author from several colonies at Port au Prince, Manneville, Diquini, Ennery and in the mountains north of Jacmel, shows that Roger's and Forel's forms are in all probability merely synonymous with Latreille's. Latreille's specimen came from San Domingo and had the anal region red like the sides of the head, but this is true also to some extent of our specimens and of the cotype *haytianus*, and, we believe, represents merely a sporadic variation the occurrence of which is rendered probable by the peculiar color of the male (*vide infra*). Roger's specimens also came from San Domingo. Forel believes that his variety certainly differs from *hamulus* in the shape of the spines on the petiole and the rugæ of the occiput, but our series shows that the small spines on the petiole are variable and may be either present or absent in individuals from the same colony, and Roger describes the occiput as coarsely longitudinally rugose ("die Hinterseite des Kopfes gröber längsrunzelig").

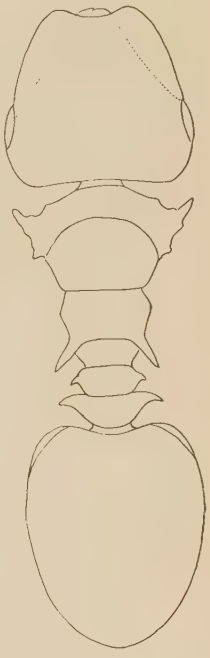

Fig. 16. *Cryptocerus hæmorrhoidalis* Latreille. Worker from above.

A single male specimen from Port au Prince is peculiar in coloration. It has the head, thorax, petiole and postpetiole black; the tips of the mandibles, palpi, legs, antennal scapes and gaster fulvous, the funiculi brown. The wings are blackish, with dark brown veins and stigma. The body is subopaque, except the gaster, which is feebly shining. The hairs are fulvous and erect, abundant and conspicuous on the head and thorax, much sparser and appressed on the gaster and legs.

Although many colonies of this ant were seen in Haiti, only one type of worker was found in them. This fact and the singular conformation of the body of the worker show a marked resemblance to the species of the genus *Procryptocerus*. The nests are usually in hollow twigs, but at Port au Prince several colonies were found nesting in fence-posts.

53. **Cryptocerus varians** *F. Smith* subsp. **marginatus** subsp. nov. (Fig. 17.)

Soldier. Differing from the typical form from Florida, Cuba and the Bahamas

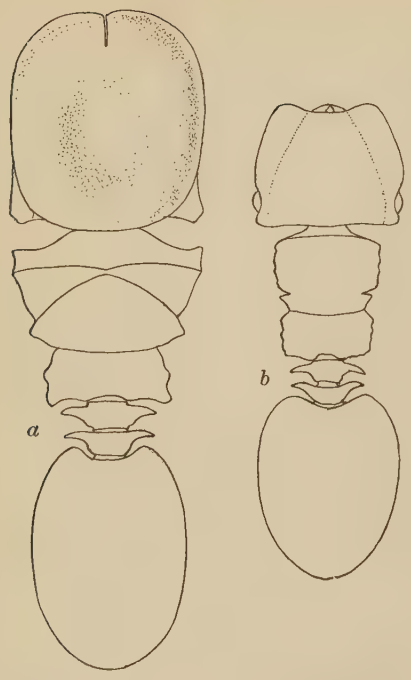

Fig. 17. *Cryptocerus varians* F. Smith subsp. *marginatus* subsp. nov. a, soldier, dorsal view; b, worker, dorsal view.

in having the spines on the petiole and postpetiole distinctly longer, the large spines on the epinotum stouter, blunter and less compressed, and the color of the body and legs darker and more blackish.

Worker. Differing from the typical *varians* in having the thorax broader, with flatter and more regular border on each side, the spines of the petiole and postpetiole much longer and flatter and the color darker as in the soldier.

Female (deälated). Color darker than in the female of the typical form, the whole body being black, with only a faint reddish tinge to the legs, thorax and pedicel.

Described from numerous soldiers and workers and a single female from Diquini, St. Marc, Petionville and Manneville. The colonies were nesting in hollow twigs on the estate at Diquini, frequently also in bamboo.

54. **Strumigenys alberti** *Forel.*

Trans. Ent. Soc. London, 1893, p. 380, ☿ ♀.

Several workers and a deälated female from Manneville, Ennery, Grande Rivière, Petionville, Diquini and the mountains north of Jacmel, agree very closely with the typical form of this species from St. Vincent.

55. **Strumigenys rogeri** *Emery.*

Pyramica gundlachi Roger, Berl. Ent. Zeitschr., 1862, VI, p. 253, ♀ (*nec* ☿).
Strumigenys rogeri Emery, Bull. Soc. Ent. Ital., 1890, XXII, p. 31, pl. 7, fig. 6, ☿.

Six workers and a deälated female from the mountains north of Jacmel. This species occurs also in St. Thomas, Cuba and Porto Rico.

56. **Strumigenys unispinulosa** *Emery.*

Bull. Soc. Ent. Ital., XXII, 1890, p. 31, pl. 7, fig. 5, ☿ ♀.

Several workers and deälated females from Cape Haitien, Grande Rivière and Diquini. This species was originally described from Alajuela, Costa Rica.

57. **Atta (Trachymyrmex) jamaicensis** *Ern. André.*

Rev. d'Entomol., 1893, p. 149, ♀ .

Numerous workers, three males and a single female from St. Marc, Diquini, Manneville and Port au Prince agreeing in all respects with specimens from Jamaica, the Bahamas and Culebra Island. This ant forms rather large colonies. At Manneville it was found nesting in dry, sandy soil on the plain near Lake Assuei. Here the insects had thrown up broad, low craters about the nest entrances. In other localities the nests were in more humid situations. In all cases, however, they were in the shade. The ants collect small pieces of leaves, buds and other vegetable substances as a substratum for the fungus which they cultivate, as has been shown by the senior author in a former paper (The Fungus Growing Ants of North America. Bull. Amer. Mus. Nat. Hist., XXII, 1907, p. 760). The workers are diurnal but seem to prefer the late afternoon for foraging.

58. **Atta (Trachymyrmex) jamaicensis** *Ern. André* subsp. **haytiana** subsp. nov. (Fig. 18.)

Worker. Length: 3.5–4 mm.

Differing from the typical form in having the anterior spines or tubercles on the posterior corners of the head shorter, in having a well-developed, pointed median

Fig. 18. *Atta (Trachymyrmex) jamaicensis* Ern. André subsp. *haytiana* subsp. nov. Worker. a, profile of body; b, head from above.

tubercle on the pronotum and in coloration, the body being entirely black, with the exception of the mandibles, funiculi, articulations of the legs and tarsi beyond the first joint, which are red.

Described from several workers taken from a single colony in a canyon near Petionville. The nest entrance opened directly on the surface of the ground and was not surrounded by a crater.

59. **Mycocepurus smithi** *Forel.*

Forel, Trans. Ent. Soc. London, 1893, pp. 370–372, ☿ .

Several workers of the typical form of this species, first described from St. Vincent, were taken at Cape Haitien and Diquini. The nests in the latter locality were in the form of small craters and were located in clay soil in a moist spot in a gully formed by a small stream. Several colonies were nesting in an area about 25 ft. square, but in no other place in the neighborhood. At Cape Haitien only a single colony was found and this was nesting in a road leading across the mountains and nearly at the summit.

60. **Cyphomyrmex rimosus** *Spinola* var. **minutus** *Mayr.*

Cyphomyrmex minutus Mayr, Verh. Zool. bot. Gesell. Wien, XII, 1862, p. 691, ☿ .

A large number of specimens of all three phases of this widely distributed form were taken at Momance, Diquini, Petionville, Ennery, Grande Rivière, Manneville, St. Marc and in the mountains north of Jacmel. These specimens vary considerably in color but this is probably due, in part at least, to age.

Subfamily Dolichoderinæ.

61. **Dorymyrmex pyramicus** *Roger* var. **niger** *Pergande.*

Proc. Cala. Acad. Sci., 1895, ser. 2, V, p. 871, ☿ .

Several workers and females from Diquini and Manneville. This dark variety seems to be the most abundant form of the widely distributed *pyramicus* occurring in the West Indies.

62. **Iridomyrmex keiteli** *Forel.*

Mitth. Naturh. Mus. Hamb., XXIV, 1907, 2. Beiheft, p. 8, ☿ ♀.

The worker of this species, which was described from specimens collected in Haiti by G. Keitel, is readily distinguished from *I. melleus* Wheeler of Porto Rico, *I. humilis* Mayr and the allied *iniquus* Mayr by its much broader and more cordate head, shorter antennal scapes, stouter thorax, shorter and less constricted mesoëpinotal region, and more erect petiolar node. The female is described as having a vertical and much broader petiolar node. The typical form of this species was not seen by the junior author in Haiti, but he encountered the two following undescribed varieties instead:

63. **Iridomyrmex keiteli** *Forel.* var. **flavescens** var. nov.

Worker. Length 2–2.3 mm.

Differing from the typical *keiteli* in its slightly larger size and in coloration, the whole body being clear yellow, except the mandibular teeth, which are black, and the occipital impression of the head, which is very feebly infuscated.

Described from several specimens taken from a nest under a stone on a dry hill-side at Cape Haitien. This variety must closely resemble *I. melleus* Wheeler subsp. *succineus* Forel from Brazil, but the latter form is decidedly larger (2.6–2.9 mm.). Judging from Forel's description it, too, would seem to belong to *keiteli* rather than to *melleus.*

64. **Iridomyrmex keiteli** *Forel* var. **subfasciatus** var. nov.

Worker. Length 2–2.3 mm.

Differing from the two preceding forms in coloration. The head, thorax, petiole and middle portions of the femora are dark brown, with the mandibles, sides of clypeus, scapes, tibiæ and tarsi yellow; the gaster yellow, with a broad, brown, transverse band on the dorsal surface of each segment. The funiculi are also brownish.

Described from several workers taken at Diquini, Petionville and in the mountains north of Jacmel.

65. **Tapinoma melanocephalum** (*Fabricius.*)

Formica melanocephala Fabr., Ent. Syst., II, 1793, p. 353, ☿ .

Three workers from Manneville.

66. **Tapinoma opacum** sp. nov.

Worker. Length 2–2.5 mm.

Head distinctly longer than broad, a little broader behind than in front, rounded behind, with feebly convex sides and rather large, flattened eyes, placed just in front of the median transverse diameter of the head. Mandibles with numerous minute teeth, the apical ones longer and acute. Clypeus moderately large and convex, with rounded, entire anterior border. Frontal area indistinct, triangular. Frontal groove obsolete. Antennæ rather long; scapes reaching fully twice their greatest diameter beyond the posterior margin of the head; second funicular joint broader than long, succeeding joints as long as broad, terminal joint longer. Thorax rather stout; pro- and mesonotum each somewhat broader than long, the meso-epinotal suture slightly but distinctly impressed in profile. Epinotum as long as broad, in profile sloping and rather flat, without distinct base and declivity. Petiole $1\frac{1}{2}$ times as long as broad, broader behind than in front, with a distinct though low scale, which is much inclined forward, narrowed and somewhat pointed anteriorly when seen from above. Gaster and legs as usual, the first segment of the former overlapping the petiole with its base.

Mandibles shining, finely punctate; remainder of body, including the antennæ and legs, opaque, very densely, finely and evenly punctate.

Hairs sparse, whitish, erect, present only on the clypeus, mandibles, prosterna and tip of gaster; pubescence whitish, very short and delicate, covering the whole body and giving it a faint bloom.

Black; legs and antennal funiculi piceous; tips of mandibles, tarsi and mouth-parts, including the palpi, yellow.

Male. Length 2.5 mm.

Resembling the male of *T. sessile* Say, except in its smaller size, sculpture and coloration. Head a little longer than broad; clypeus with straight, entire anterior border. Antennal scapes more slender than in the worker and reaching further beyond the posterior border of the head; funicular joints all distinctly longer than broad. Epinotum similar to that of the worker, but with more distinct base and declivity, the former fully twice as long as the latter. Petiole with a thick, low, erect, rounded node. Genitalia large, the external valves convex, rounded, as broad as long, internal valves much narrower, pointed and more claw-like than in *T. sessile*. Wings without a discoidal cell.

Sculpture like that of the worker, except the gaster, which is shining

Erect hairs even less developed than in the worker, absent on the head and gaster.

Color as in the worker; wings distinctly grayish, with darker gray veins and stigma.

Described from several workers and two males taken at Furcy beneath the bark of a fallen pine. This species is clearly distinct from any of the other described American members of the genus and can be readily recognized in the worker and male phases by its peculiar sculpture. The male is fully as large as the worker, so that it is excluded from the group of species comprising *T. melanocephalum,* Fabr., *litorale* Wheeler, *ramulorum* Emery, etc. and belongs in the group containing *T. erraticum* Latr. and *sessile* Say. The genitalia are also more massive as in these latter species.

Subfamily Camponotinæ.

67. **Brachymyrmex heeri** *Forel.*

Denkschr. schweiz. Ges. Naturw., XXVI, 1874, p. 91, ♀, taf. 1, fig. 17.

Three females, a male and several workers from Manneville belong to the typical yellow form of this well-known species. It was also found to be very common beneath stones, boards etc. on the shores of the salty Lake Assuei.

68. **Prenolepis (Nylanderia) vividula** *Nylander* subsp. **guatemalensis** *Forel* var. **itinerans** *Forel.*

Mitth. Naturh. Mus. Hamb., XVIII, 2. Beiheft, 1901, p. 81, ♀.

Several workers, females and males from Petionville, Manneville and Diquini. The workers agree perfectly with cotypes received from Prof.

Forel. These had been imported into Hamburg with orchids from Brazil. Both the male and female are pale yellow, the latter with a broad, deep brown band across the dorsal surface of each gastric segment and with the surface of the body more opaque and pubescent than that of the worker, as usual in the genus. The wings in both sexes are yellowish hyaline, with pale yellow veins and stigma and not infuscated as described by Forel for the typical *guatemalensis* and its var. *antillana* Forel.

69. **Prenolepis (Nylanderia) steinheili** *Forel.*

Trans. Ent. Soc. London, 1893, p. 342, ♀.

A few workers from Furcy and Manneville and a winged female from the former locality. This sex, which was not described by Forel, measures 4 mm. and does not, therefore, reach the size (4.4 mm.) which he records for the female of his var. *minuta.* It is dark brown, with yellow appendages, the gaster being darker than the head and thorax and with each of its segments bordered posteriorly with yellow. The wings are grayish hyaline, with pale brownish veins and stigma.

70. **Prenolepis (Nylanderia) fulva** *Mayr.*

Verh. Zool. bot. Gesell. Wien, XII, 1862, p. 698, ♀ ♀.

Recorded by Forel from Haiti (Mitth. Naturh. Mus. Hamb., XVIII, 1901, 2 Beiheft, p. 65).

71. **Prenolepis (Nylanderia) longicornis** (*Latreille*).

Formica longicornis Latreille, Hist. nat. Fourmis, 1802, p. 113, ♀.

Numerous workers and two deälated females from Diquini, St. Marc, Manneville and Petionville. This introduced species is very widely distributed in Haiti and is especially common on the western shore of Lake Assuei.

72. **Prenolepis (Nylanderia) longicornis** (*Latreille*) var. **hagemanni** *Forel.*

Mitth. Naturh. Mus. Hamb., XVIII, 2 Heft, 1901, p. 65, o; *ibid.*, XXIV, 2 Beiheft, 1907, p. 10, ♀.

This variety, originally described from the Congo, is recorded by Forel from Port au Prince. It is paler than the typical *longicornis,* the worker being "yellowish red, with the antennæ, palpi and legs whitish, excepting the coxae."

73. **Rhizomyrma parvidens** sp. nov.

Worker. Length 1.8–2 mm.

Head subrectangular, a little broader than long, as broad in front as behind, with straight sides and a slight angular excision in the middle of the posterior border. Eyes minute, consisting of about 4 small ommatidia, situated at the anterior third of the head. Mandibles oblique but with distinct basal and apical borders, the latter with 4 small subequal teeth, much smaller than in any of the known species of the genus. Clypeus short and convex, with the anterior border entire, straight and transverse in the middle. Frontal area distinct, triangular; frontal and occipital grooves distinct. Antennæ 10-jointed; scapes reaching to the posterior corners of the head; first funicular joint longer than broad, second joint small, as long as broad; joints 3–5 much broader than long, joints 7–8 as long as broad, terminal joint as long as the 3 preceding joints together. Thorax shaped much as in *Rh. goeldii* Forel, but shorter and stouter, at least behind, where it is as broad as in front; seen from above the sides are rather concave in the middle; pronotum much broader than long, with less convex humeri than in *goeldii*, mesonotum not longer than broad, as it is in *goeldii*, fitting into the semicircular excavation of the posterior portion of the pronotum, convex and rising above the latter in profile, abruptly sloping behind to the mesoëpinotal constriction which is pronounced but very short Epinotum distinctly broader than long, in profile lower than the mesonotum, with rather straight base and declivity meeting at a rounded, obtuse angle, the base distinctly longer than the declivity. Petiole with an erect, well-developed scale, which is a little more than half as broad as the epinotum, but not as high, compressed anteroposteriorly, with flattened anterior and posterior surfaces and rather blunt, entire, broadly rounded superior border. Gaster rather large, elliptical. Legs stout.

Body shining, finely shagreened and sparsely punctate. Mandibles and clypeus somewhat more opaque.

Hairs and pubsecence whitish or pale yellow, the former rather long, unequal, erect and confined to the body, the latter rather dense and short, covering both body and appendages, but not obscuring the shining surface.

Pale brownish yellow throughout; legs and antennæ a little paler, head in some specimens a little darker, only the eyes and mandibular teeth brown.

Described from three workers, two taken at Petionville and one at Diquini. This species may be the worker of *Rh. smithi* Forel, which is known only from the female taken in St. Vincent. The worker is certainly very different from *Rh. goeldii* Forel of Brazil and *exsanguis* Wheeler of Mexico in the structure of the mandibles and thorax. Moreover the integument is not thin and collapsible as in *exsanguis*, the eyes are somewhat larger and the second funicular joint is longer. The worker *goeldii* has 11-jointed antennæ (at least this is the number in a cotype received from Prof. Forel) and the second funicular joint is decidedly transverse. The mandibles of *Rh. parvidens* are much like those of *Rh. decedens* Mayr of South America but the median funicular joints are much shorter and broader. *Rh. pachycerus* Emery of Alto Paraná has 9-jointed antennæ, the scapes do not reach

the posterior corners of the head and the apical borders of the mandibles are very oblique. The worker of this species measures 2.2 mm. and is therefore larger than *parvidens*.

74. **Rhizomyrma dubitata** sp. nov.

Male. Length 2 mm.

Very similar to the male of *Acropyga*. Head a little broader than long, subrectangular. Eyes rather small, less than half as long as the sides of the head. Mandibles slender, distinctly tridentate. Clypeus convex and almost carinate in the middle, with entire, rounded anterior border. Antennæ with long scapes, which reach well beyond the posterior corners of the head; first funicular joint globular, as broad as long, joints 2–7 a little broader than long, remaining joints longer. Thorax robust but not much broader than the head through the eyes. Mesonotum convex in front, slightly overarching the pronotum; scutellum not convex; epinotum rounded, sloping, without distinct base and declivity. Petiole with erect node, which is rather thick though compressed anteroposteriorly, with a blunt, rounded, entire border. Its anterior face in profile is slightly convex, its posterior face more flattened. Gaster rather short and stout; external genital valves large, with broad, bluntly bidentate tips; inner valves shorter, unciform. Wings rather large, like those of *Acropyga* with one cubital cell, no discoidal cell and the radial cell closed.

Body shining throughout and very finely shagreened.

Hairs pale, erect, absent on the thorax and anterodorsal portion of the gaster, conspicuous on the petiole, venter and genitalia. Pubescence whitish, fine and rather dense, but not concealing the shining surface.

Yellow throughout; appendages scarcely paler; only the ocellar triangle blackish or fuscous. In some specimens the body is very slightly tinged with brown. Wings yellowish gray, with colorless veins and stigma.

Described from numerous specimens taken by Mr. Aug. Busck in the San Francisco Mts. of San Domingo. This may be the male of the preceding species or of *Rh. smithi* Forel, but as it was not taken with workers and as it is the first male of the genus to be recorded, we deem it advisable to describe it under a new name. Specimens of *Rhizomyrma* are rare in collections. The species, as shown by their pale yellow color and the vestigial eyes of the workers, are evidently hypogæic and attend root-coccids like the species of *Brachymyrmex* and *Acanthomyops*. At least these are the habits observed in one of the South American species (*Rh. goeldii*).

75. **Camponotus maculatus** *Fabricius* subsp. **plombyi** subsp. nov. (Fig. 19.)

Worker major. Length 10–11.5 mm.

Head moderately large, longer than broad, somewhat broader behind than in front (3.5 mm. long, 3 mm. broad), with slightly excavated posterior border, rather angular posterior corners and feebly and uniformly convex sides. Mandibles long, 7-

toothed. Lobe of clypeus short, slightly projecting on the middle, angular on the sides. Antennal scapes extending fully one third their length beyond the posterior corners of the head. Thorax long, slender and low; pronotum more than half as broad as the head; base of the epinotum about twice as long as the declivity, the angle between the two rounded and indistinct. Petiole small, its anterior surface convex, its posterior surface flattened, its border rather sharp. Hind femora not compressed, without a row of graduated bristles on the flexor surfaces of the tibiæ.

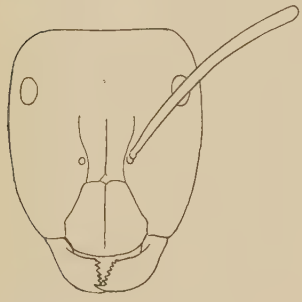

Fig. 19. *Camponotus maculatus* Fabricius subsp. *plombyi* subsp. nov. Head of worker major from above.

Shining and finely shagreened; mandibles, clypeus and head coarsely and rather sparsely punctate, the punctures becoming smaller and more scattered on the posterior portion of the head. Scapes opaque. Thorax and gaster with scattered piligerous punctures; scapes and legs with more numerous punctures.

Hairs fulvous, rather coarse, erect, not only on the body, but also on the scapes, short on the latter, the mandibles, cheeks, clypeus and upper surface of the head, long and more abundant on the thorax, petiolar border and gaster, very short and suboblique on the legs.

Black; mandibles, except their teeth, anterior half of clypeus, funiculi, tibiæ, knees and tarsi, dark red; gastric segments narrowly margined behind with sordid yellow.

Worker minor. Length 8–9 mm.

Head somewhat less than twice as long as broad, a little broader in front than behind, with straight sides, rounded posteriorly, the occipital border being short and feebly concave. Mandibles and clypeus similar to those of the worker major. Antennæ slender; scapes extending one half their length beyond the posterior border of the head. Thorax and gaster slender; base of epinotum very feebly concave in profile. Petiolar node thicker and blunter than in the worker major. Sculpture, pilosity and color much as in that phase, but the punctuation of the head much feebler. Legs somewhat paler in some specimens, the femora and coxæ being dark brown or reddish.

Described from a number of specimens taken in the mountains at Furcy, living in crater nests in the ground. This subspecies which is dedicated to the genial Abbé Plomby, closely resembles the subsp. *dominicensis* Wheeler from the island of Dominica in sculpture, pilosity and form, but the color is very different, the head of the major worker is decidedly shorter and the anterior border of the clypeus projects somewhat in the middle, where it is very feebly and sinuately notched.

76. **Camponotus maculatus** *Fabr.* subsp. **haytianus** subsp. nov. (Fig. 20.)

Worker major. Length: 11–12 mm.

Head large, subtriangular, a little longer than broad (4.3 mm. long, 4 mm. broad), much narrower in front than behind, with broadly and rather deeply excised posterior

border, prominent posterior corners, and rather straight sides. Mandibles long, convex at their tips, 8-toothed. Clypeal lobe rather long, its median border transverse, straight or very feebly sinuate its corners blunt and rounded. Antennæ slender, their scapes curved and extending less than one third their length beyond the posterior corners of the head. Thorax rather slender, and low, through the pronotum about one half as broad as the head. Epinotum long, base in profile straight or very feebly convex, about twice as long as the declivity into which it passes through a rounded, obtuse angle. Petiolar node in profile cuneate, thick at the base, rather pointed at the summit, with very feebly convex anterior and posterior surfaces; seen from behind its margin is rounded and bluntly pointed in the middle. Posterior tibiæ not compressed and not bearing a row of graduated bristles on their flexor surfaces.

Shining and very finely shagreened; mandibles opaque and finely granular at the base, with only a few scattered, coarse punctures along the dental border. Cheeks, clypeus and front without coarse punctures and the piligerous punctures

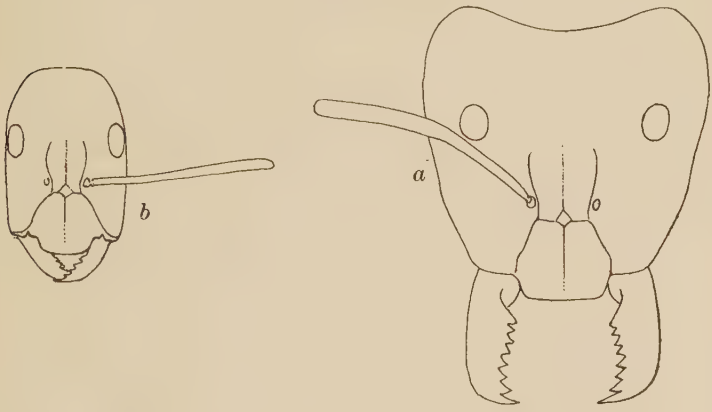

Fig. 20. *Camponotus maculatus* Fabr. subsp. *haytianus* subsp. nov. a, head of worker major from above; b, head of worker minor from above.

covering these and other portions of the body very small and sparse. Meso- and epinotum subopaque.

Hairs yellow, erect, sparse; long on the body, shorter but very conspicuous on the scapes and tibiæ; those on the mandibles very short; cheeks altogether without hairs.

Head dark blackish brown; mandibles, antennæ, clypeus and front dark red; thorax and gaster yellow, the mesonotum and in some specimens also the pronotum and epinotum, but to a less extent, infuscated. Each gastric segment with a broad, not very sharply defined, brown band across its posterior half; tibiæ and tarsi slightly reddish.

Worker minor. Length 7–9 mm.

Head a little more than $1\frac{1}{2}$ times as long as broad, very slightly broader in front than behind, with straight sides and the postocular portion rather short and semicircular behind, with short, concave occipital border. Antennæ very slender, their scapes reaching about one half their length beyond the posterior corners of the head. Thorax and petiole similar to those of the worker major.

In sculpture, pilosity and color similar to the worker major, but the mandibles, clypeus, cheeks and front more yellowish.

Described from numerous specimens taken from nests in the soil at Diquini and Port au Prince. This is a very interesting subspecies, easily distinguished from our other North American forms of *maculatus* by the large, triangular head of the worker major. In this character it closely resembles many of the Old World subspecies.

77. **Camponotus maculatus** *Fabr.* subsp. **fraterculus** subsp. nov. (Fig. 21.)

Worker major. Length 8–9 mm.

Differing from the preceding subspecies in its smaller size, more coarsely shagreened surface, in having the short hairs covering the dorsal surface of the head and the cheeks more numerous and the surface more punctate. The antennal scapes bear very few erect hairs and those on the tibiæ are shorter, less abundant and much more appressed. The head is brown, with the posterior corners, posterior border and clypeus, except its borders, brownish yellow; cheeks and vertex darker brown or blackish. Pro-, meso-, and epinotum each with a large brown or blackish patch above, that on the pronotum enclosing two elliptical yellow spots. The transverse bands on the gaster are darker and more sharply defined than in *haytianus*. The antennal scapes are dark brown, the funiculi brownish yellow.

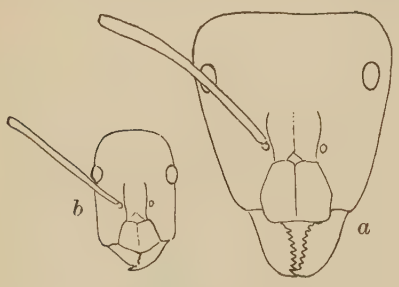

Fig. 21. *Camponotus maculatus* Fabr. subsp. *fraterculus* subsp. nov. a, head of worker major from above; b, head of worker minor from above.

Worker minor. Length 5–6.5 mm.

Yellow nearly throughout, the vertex of the head in some specimens slightly infuscated. Legs and scapes with very fine, dense, appressed pubescence; scapes also with a few scattered, erect hairs.

Described from numerous specimens taken at Furcy where they were nesting in the same stations and in the same manner as the specimens of the subspecies *plombyi* described above.

78. **Camponotus maculatus** *Fabr.* subsp. **soulouquei** *Forel.*

Forel, Mitth. Naturh. Mus. Hamb., XVIII, 1901, 2. Beih. p. 68, ♀.

Worker major (after Forel). Length 6.8 mm.

Similar to *C. ustus* Forel in external appearance, but the head much shorter, more triangular, broader behind, narrower in front, less shining. On the other hand,

very close to the subsp. *toltecus* Forel, but somewhat smaller, with somewhat more vivid coloration and with distinct, more abundant, short, yellowish, suberect hairs on the antennal scapes, and on the flexor surfaces of the tibiæ with oblique hairs, which are lacking in the subsp. *toltecus*. Scapes brownish red (brownish black in *toltecus*). The cheeks are hairy in both subspecies. In *C. soulouquei* the epinotal declivity is more distinctly marked off from the base. The clypeal lobe is also less distinct, more trapezoidal. The head is yellowish behind and below, above and in front brownish or reddish, the mandibles slightly shining, very finely reticulate and sparsely punctate (rather shining in the subsp. *toltecus*).

Female. Length 11.2 mm. The gaster has a dark brown transverse band on each segment. In other respects like the major worker. Legs yellow, tarsi, especially on the posterior legs, darker. Wings yellowish, with pale veins and stigma.

Gonaives, Haiti, May 10, 1894 (H. Nepperschmidt).

We are unable to recognize this subspecies among the material collected by the junior author.

79. **Camponotus fumidus** *Roger* var. **illitus** var. nov. (Fig. 22.)

C. fumidus var. Emery, Zool. Jahrb. Abth. f. Syst., VII, 1893, p. 670, ♀.

C. fumidus Dalla Torre, Catalog. Hymen., VII, 1893, p. 232.

Worker major. Length 8–9 mm.

Closely resembling *C. fumidus* var. *festinatus* Buckley of Texas, except in the following particulars: The antennal scapes are somewhat shorter and are covered with abundant, short, suberect hairs and the hairs covering the upper surface of the head, thorax and gaster are also more abundant. The scapes are red instead of

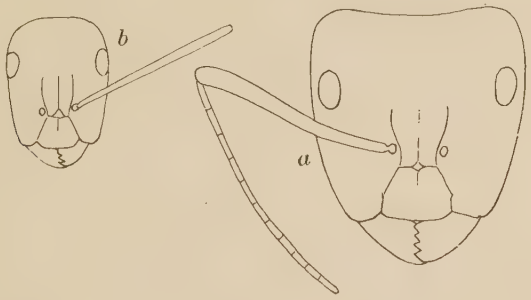

Fig. 22. *Camponotus fumidus* Roger var. *illitus* var. nov. a, head of worker major from above; b, head of worker minor from above.

black, and the tibiæ and tarsi are darker. The head is brownish yellow, the vertex with an elongate, well-defined, dark brown spot, which sends off a dark line to each eye. In some specimens the cheeks, too, are brown or reddish.

Worker minor. Length 6–7 mm.

Head distinctly shorter than in *festinatus* and distinctly narrowed in front, whereas in the Texan form the head is as broad in front as behind. Antennal scapes pilose as in the worker major and the hairs on the body somewhat more abundant than in *festinatus*. Whole body yellow, except the mandibles and edge of clypeus, which are red.

Described from several specimens taken from nests in the ground at Port au Prince, Diquini and Grande Rivière. There seems to be little doubt that this is the form regarded by Emery as a variety of *fumidus*. The true *fumidus*, originally described from Venezuela, has not since been observed, so that the Texan and Haitian forms have, perhaps, only a provisional status as varieties.

80. **Camponotus fumidus** *Roger* var. **imbecillus** var. nov.

Worker major.

Allied to *C. fumidus* var. *fragilis* Pergande, but differing in the following characters: The head is shaped as in the vars. *illitus* and *festinatus* and is distinctly broader than in *fragilis* and bears on the vertex a dark brown spot which is absent in this variety. The yellow color of the body and especially of the head is darker and more reddish, and the brown bands on the gaster are darker and more sharply defined. The suberect hairs on the antennal scapes are about equally abundant in both varieties, the hairs on the body are more abundant in *imbecillus*.

Worker minor. Indistinguishable from the corresponding phase of *fragilis*.

Described from four major and four minor workers taken at Grande Rivière. These have been compared with cotypes of *fragilis* received from Mr. Pergande by the senior author several years ago.

81. **Camponotus larvigerus** sp. nov. (Fig. 23.)

Worker major. Length 7.5–8.5 mm.

Belonging to the *maculatus* group and related to *C. ramulorum* Wheeler. Head moderately large, as broad as long, considerably broader behind than in front, with broadly excised posterior border and convex sides. Eyes flattened. Mandibles rather short, convex, with 7 subequal teeth. Clypeus sharply carinate, its border

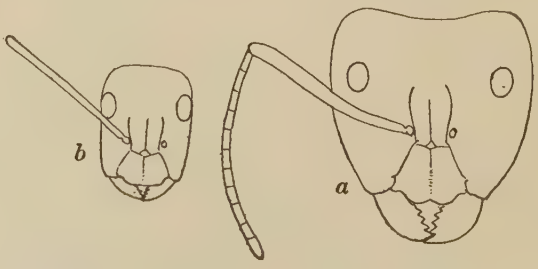

Fig. 23. *Camponotus larvigerus* sp. nov. a, head of worker major from above; b, head of worker minor from above.

very slightly projecting, divided into two short, equal, rounded lobes by a distinct but narrow median notch. Frontal area small, distinct. Frontal carinæ sigmoidal, as closely approximated behind as in front. Vertex with three distinct, pit-like impressions simulating ocelli. Antennal scapes curved, somewhat flattened towards

their tips, extending about one third their length beyond the median posterior border of the head. Thorax through the pronotum nearly two thirds as broad as the head, laterally compressed in the meso- and epinotal regions, in profile evenly arched above; epinotum with distinct base, and declivity, the latter distinctly concave, more than half as long as the base. Petiolar node compressed anteroposteriorly, not thick at the base, as high as the epinotal angle, its anterior surface slightly convex, its posterior surface flattened, its border moderately rounded and entire when seen from behind. Fore femora incrassated; hind tibiæ not compressed, without a row of graduated bristles on their flexor surfaces.

Shining throughout and very finely shagreened. Mandibles, clypeus and dorsal surface of head with small, uniform, shallow punctures.

Hairs yellow, sparse, present on the upper surface of the head, clypeus, thorax, petiole and gaster, absent on the cheeks and sides of the head. Scapes on their anterior surface and at their tips with a few short, erect hairs. Legs without hairs except at the tips of the femora. Pubescence very short and sparse, visible only on the gaster.

Mandibles, clypeus, gula and head dark brown or black; posterior corners and posterior border of head light yellow. Antennal scapes dark red, infuscated distally; funiculi brownish yellow. Thorax, petiole, gaster and femora yellow; mesonotum, upper portion of epinotum and pronotum dark brown, the latter in its dark area with two large, elliptical yellow spots, which are sometimes confluent with the yellow on the pleuræ. Gaster with a well-defined, broad, transverse, dark brown band on each segment. Tibiæ and tarsi reddish.

Worker minor. Length: 5.5–6.5 mm.

Head somewhat more than $1\frac{1}{2}$ times as long as broad, as broad in front as behind, with straight sides and short, rounded postocular region. Clypeus with entire, broadly rounded and rather projecting anterior border. Antennæ slender, scapes not enlarged distally, extending about one half their length beyond the posterior border of the head. Thorax slender, base of epinotum twice as long as the declivity. Petiolar scale less compressed anteroposteriorly than in the major worker, broader at the base and more cuneate in profile.

Sculpture and pilosity much as in the major worker but head impunctate and antennal scapes without erect hairs.

Color yellow, except the mandibles and tarsi, which are red.

Female. Length 9.5–10.5 mm.

Resembling the major worker but the head much narrower, longer than broad, with straight sides and the clypeus with its median border straight and transverse in the middle and angulate at the sides. Thorax narrow, the epinotum with convex base, which is about half as long as the abrupt, feebly concave declivity. Petiole as in the major worker.

Sculpture and pilosity much as in the major worker. Head with the yellow of the posterior corners extending forward and enclosing the eyes and front, and the anterior portion of the clypeus also yellowish. The brown of the remaining portions paler than in the worker major. The thorax is pale yellow, with restricted clouds of dark brown on the mesonotum, scutellum and epinotum. Wings yellowish, with pale yellow veins and stigma.

Described from numerous specimens taken from two colonies at Grande Rivière. At first sight this species would seem to be merely a small sub-

species of *maculatus*, but if it were reduced to this rank, *C. ramulorum* Wheeler and *ustus* Forel would also have to be regarded as subspecies of *maculatus*. From *ramulorum*, *larvigerus* differs in its larger size, the shape of the clypeus in the major worker and the peculiar coloration and more pronounced punctuation of the head in this phase.

82. **Camponotus ustus** *Forel.*

Bull. Soc. Vaud. Sc. Nat., XVI, 1879, p. 75, ☿ ♀ ♂; Mitth. Naturh. Mus. Hamb., XXIV, 1902, 2. Beiheft, p. 11, ☿ ♀.

The types of this species came from St. Thomas. It is also recorded by Forel from Port au Prince, Haiti, and we have before us a major worker received from Forel and taken in that locality by Mr. G. Keitel. It agrees very closely with Forel's description but the erect hairs on the scapes are more abundant. The whole upper surface of the head, including the cheeks, is hairy and the tibiæ have short but distinct hairs. The brown on the head is not very deep nor sharply defined, and the same is true of the transverse bands on the gaster. The specimen measures about 6 mm. All of the specimens collected by the junior author differ from this specimen, and represent the three following varieties.

83. **Camponotus ustus** *Forel* var. **ulysses** *Forel.*

Mitth. Naturh. Mus. Hamb., XXIV, 2. Beiheft, 1907, p. 11, ☿ ♀ ♂.

Worker major (after Forel). Length 7 mm.

Somewhat larger than the type of the species. Head broader and shorter. Epinotum forming a single arc, whereas in *ustus* (typical) it is higher and has a distinct basal and declivous surface. The sculpture is more sharply reticulate, especially on the head, so that the surface is less shining. The gaster has brown bands which are sharply marked off from the yellow ground color (in the typical *ustus* the bands are more diffuse).

Female. Length 10.5 mm.

Differing from the type in the same characters as the worker major. Head feebly shining or only lustrous (strongly shining in the type of the species), with distinct, scattered, coarse punctures. Epinotum less cuboidal. The wings are yellowish (in the type of the species nearly colorless). The brown bands on the gaster are very sharply defined.

Male. Length 7 mm.

Unusually large, gaster without transverse bands. Less shining than the type of the species. In other respects scarcely distinguishable except by the more yellowish tint of the wings. It belongs, at least very probably, to this variety.

Isla de Cabrilos in Lake Assuei and Port au Prince (G. Keitel); the male from Port au Prince.

It seems to us very probable that the male does not belong to this variety but to some one of the subspecies of *maculatus* described above. We refer to this variety several series of workers from Grande Rivière, Cape Haitien, Petionville, Ennery, Manneville and Port au Prince. All the specimens agree well with Forel's description except that the head and mandibles of the worker major are more shining and the thorax is slightly clouded with fuscous. The cheeks and scapes bear short, erect hairs but fewer than in the true *ustus,* apparently. In the minor workers the cheeks are naked and the scapes bear only a very few, scattered, suberect hairs.

84. **Camponotus ustus** *Forel* var. **sublautus** var. nov.

Worker major. Length: 6.5–7.5 mm.

Differing from the typical *ustus* and the var. *ulysses* in having no erect hairs on the cheeks and sides of the head, or even oblique hairs on the tibiæ, and the hairs on the body are much less abundant. The scapes are either naked or have only 3 or 4 erect hairs on their anterior surfaces. The coloration of the head is much like that of *C. fumidus* var. *illitus,* the cheeks, a large rectangular spot on the vertex, connected with each eye by a transverse line, being light or dark brown, while the remainder of the head, clypeus and front are brownish yellow. The punctures on the cheeks are small and superficial, the head and mandibles are more shining than in *ustus* and its var. *ulysses.* The epinotum is distinctly angular, with subequal base and declivity, the former feebly convex, the latter feebly concave. The brown bands on the gaster are faint and poorly defined as in the true *ustus.*

Worker minor. Length 5–6 mm.

Head subrectangular, only $1\frac{1}{2}$ times as long as broad, as broad in front as behind, with straight sides, straight posterior border and rounded posterior angles. Antennal scapes reaching about half their length beyond the posterior corners of the head. Thorax shaped much as in the major worker. Pilosity and sculpture very much as in the latter phase, but the scapes are always without erect hairs. Pale yellow throughout, except the mandibles, which are reddish.

Described from several specimens taken at Diquini.

85. **Camponotus ustus** *Forel* var. **furnissi** var. nov.

Worker major.

Differing from the preceding variety in the color of the head, which is yellow throughout, except for an elongate, subquadrate brown blotch on the vertex extending forward somewhat between the frontal carinæ. The mandibles are red and somewhat paler than in the var. *sublautus.* In other respects like that variety.

Worker minor.

Distinguishable from the worker minor of *sublautus* only by the mandibles, which are pale yellow like the remainder of the body.

Female (deälated). Length 9.5 mm.

Colored like the worker major, except that the brown transverse bands on the gaster are darker and more sharply defined.

Described from several workers and a single female taken from two colonies, one at Petionville, the other at Manneville. The two new varieties described above, which are clearly intermediate between the typical *ustus* and *C. ramulorum* Wheeler of the Bahamas and Cuba, show that the latter form can hardly be maintained as a distinct species, but should more properly be regarded as a subspecies of *ustus*. The worker major of the typical *ramulorum* is distinguished from the *ustus* forms by its smoother and more shining surface, impunctate head and the brighter, deeper and more sharply outlined brown markings, which extend also to the thorax. The pilosity is even sparser than in the vars. *sublautus* and *furnissi*, and the legs and body are without traces of pubescence and the scapes are quite naked.

The whole series of forms described in the preceding paragraphs, including *larvigerus, fumidus, ustus* and *ramulorum* and their varieties form a compact group of closely allied forms which, were it not for unduly complicating matters, one might be tempted to attach to *maculatus* as so many subspecies or varieties, since they all differ from one another merely in minor morphological characters and in pilosity and coloration. The coloration, especially of the head and gaster, shows curious similarities in all the forms.

86. **Camponotus sexguttatus** (*Fabricius*).

Formica sexguttata Fabricius, Ent. Syst., II, 1793, p. 354, ♀ .

A female, a worker minor and three males belonging to the typical dark form of this species, taken in the San Francisco Mts. of San Domingo by Mr. Aug. Busck.

87. **Camponotus claviscapus** *Forel* subsp. **occultus** subsp. nov. (Fig. 24.)

Worker major. Length 5.5–6.5 mm.

Differing from the typical *claviscapus* of Trinidad and its var. *subcarinatus* Forel of Central America in its somewhat smaller size, in having the sides of the clypeus more nearly straight and parallel and the punctures on the mandibles, clypeus, cheeks and front denser and larger, so that these portions of the head are nearly subopaque. The base and declivity of the epinotum meet at nearly a right angle, which is blunt but distinct, the declivity being concave. The thorax is uniformly yellow throughout, as is also the posterior border of the head, and the brown bands on the posterior borders of the gastric segments are nery narrow.

Worker minor. Length 4–5.5 mm.

Differing from the worker of the typical form in having the clypeus distinctly carinate and in the paler color of the body, which is yellow throughout, with the head a little darker and more reddish and without brown bands on the gaster.

Female (deälated). Length 7 mm.

Closely resembling the major worker but the head proportionally shorter and smaller. The thorax is elongate elliptical, its upper surface very smooth and shining. The body is pale yellow, the head slightly but uniformly reddish, much paler than in the worker major, the mandibles dark red, the gaster with a distinct transverse brown stripe near the posterior border of each segment. The female of the var. *subcarinatus* has the head and gaster much darker and even the thorax tinged with brown.

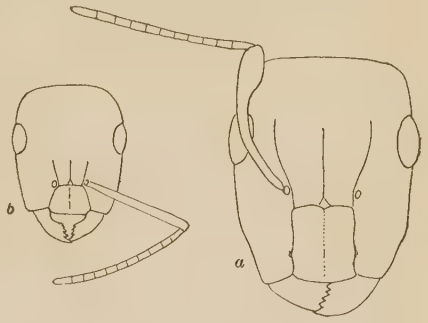

Fig. 24. *Camponotus claviscapus* Forel subsp. *occultus* subsp. nov. a, head of worker major from above; b, head of worker minor.

Male. Length 3.5–4 mm.

Differing from the male of the typical *claviscapus* and its var. *subcarinatus* in its smaller size and pale color. The whole body is pale yellow and there are no brown bands on the gaster. The wings are nearly colorless, with very pale yellow veins and stigma.

Described from several workers, two males and one female taken from hollow twigs and bamboo at Petionville, Diquini, St. Marc and Port au Prince. This form should, perhaps, rank as a distinct species. We have not seen typical specimens from Trinidad although we have compared the Haitian form with large series of all four phases of the var. *subcarinatus* taken by the senior author in Costa Rica and Guatemala and with a number of workers of a form which if not identical with, is nevertheless very close to, the typical *claviscapus*, collected by the junior author in Brazil.

88. **Camponotus christophei** sp. nov. (Figs. 25 and 26.)

Major worker. Length 5–6 mm.

Head rather large, subtrapezoidal, seen from above as broad as long, broadest behind, with rather straight posterior border and rectangular posterior corners, each with a sharp ridge running to the eye, the sides flattened behind and below this ridge, the cheeks rather convex. In profile the head is convex above and below, with elliptical, rather large, flattened eyes situated behind its median transverse diameter. Mandibles small, very convex, 5–6-toothed. Clypeus flat, indistinctly carinate, its anterior border sinuately excised in the middle. Frontal area obsolete. Frontal carinæ curved, but rapidly diverging behind where they are fully twice as far apart as in front. Frontal groove absent. Antennæ slender, scapes curved, but slightly enlarged towards their tips, which extend a little beyond the posterior corners of the head. Thorax short, flattened above and on the sides, the pronotum less than twice as broad as long, broader in front where it is a little narrower than the head, rounded and produced in the middle anteriorly over the neck, with each side expanded into a sharp, aliform plate, which is slightly reflected. Its outline

seen from above is slightly rounded and produced at the anterior corner as a distinct triangular tooth. Promesonotal suture very distinct, meso- and epinotum fused to form a single mass which is about as long as, but much narrower than the pronotum; the mesonotum trapezoidal, less than twice as broad as long, strongly marginate on the sides which are straight and separated from the base of the epinotum by a straight, transverse ridge, instead of the suture, which is absent. Epinotum very short, high in profile, with very abrupt, slightly concave declivity and extremely short, feebly convex base, the two surfaces forming a distinct angle with each other. Petiole nearly as broad as the epinotum behind, but its scale much lower than the base of the epinotum, much compressed anteroposteriorly, with rather sharp, broadly rounded superior border. Gaster oval, broader in front than behind, distinctly flat-

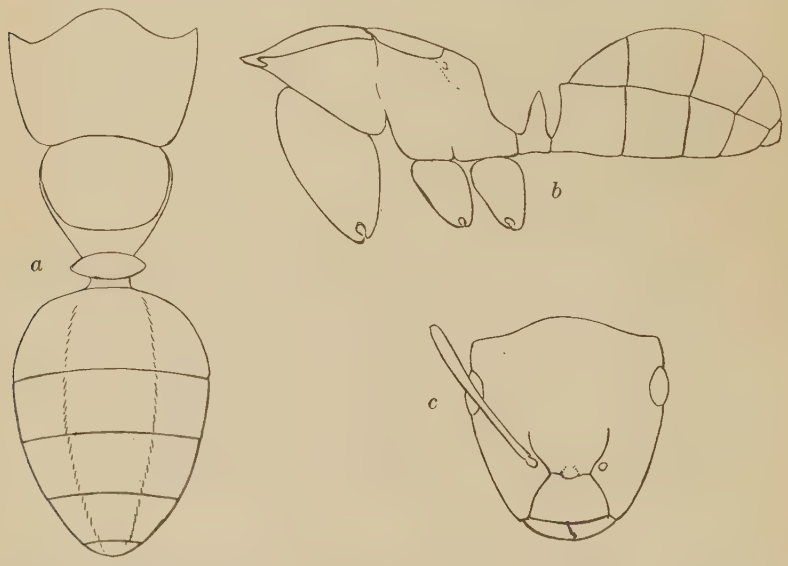

Fig. 25. *Camponotus cristophei* sp. nov. Worker. a, dorsal view of body; b, profile of body; c, head from above.

tened dorsoventrally, the first segment sharply marginate anteriorly. Legs rather stout.

Opaque; head and thorax very densely and uniformly punctate; sides and posterior portion of head and the pleuræ also finely and regularly longitudinally rugulose. Gaster with a velvety texture produced by extremely fine and dense shagreening. Posterior margin of head, mandibles and anterior surfaces of fore legs shining.

Hairs white, coarse, blunt, suberect, most abundant on the upper surface of the head, pro- and mesonotum, base of epinotum and border of petiole; sparser on the gaster, appressed on the pleuræ. Flexor borders of femora with a fringe of similar hairs. Pubescence white, appressed, short and coarse on the body and the legs, except on the upper surface of the gaster, where it is long and aggregated on each side to form a broad yellowish white band, which tapers anteriorly and posteriorly. On the venter there are two patches of similar appressed pubescence, but shorter

and less dense. The pubescence on the remainder of the gaster is even shorter and sparser than on the head.

Black; antennae light red; mandibles and last tarsal joints dark red; angles of pronotum brownish, somewhat translucent.

Fig. 26. View in the Citadel of Cristophe where *Camponotus cristophei* sp. nov. was taken.

This very beautiful species, which, with the two following forms is related to *C. saussurei* Forel, is described from four specimens taken near Milot on blades of a tall grass outside the citadel of Henri Christophe, former king of Haiti and also running about on the stone-work inside the fortification.

89. **Camponotus christophei** subsp. **augustei** subsp. nov.

Worker major. Length 5–6 mm.

Closely resembling the preceding species in form, sculpture, pilosity and color but differing in having the petiole somewhat broader and in completely lacking the two pale bands of long appressed pubescence on the gaster.

Worker minor. Length 4.5–5.5 mm.

Differing from the major worker in its somewhat smaller average size, smaller head, slightly narrower thorax, less convex and more sloping epinotum, and narrower and less reflected and less angular pronotal borders. The gaster is covered uniformly with short, sparse, blunt, white pubescence, like that on the head and thorax.

Described from six major and four minor workers found running about on leaves at Petionville. The minor workers show conclusively that the specimens have not lost white bands through rubbing. This subspecies is dedicated to the late president of Haiti, M. Tancrède Auguste.

90. **Camponotus toussainti** sp. nov. (Fig. 27.)

Worker minor. Length: 4–5 mm.

Head trapezoidal, as broad as long, broader behind than in front seen from above, with evenly and feebly convex posterior and lateral borders; each posterior corner connected with the eye by a distinct ridge. Mandibles small, convex, apparently 4–5-toothed. Clypeus flattened, ecarinate, trapezoidal, its anterior border not produced, sinuately notched in the middle. Frontal area and groove absent. Antennæ rather slender, scapes feebly enlarged at their tips and extending a litte beyond the posterior corners of the head. Thorax short, with distinct promesonotal but no mesoëpinotal suture, feebly arcuate in profile, flattened on the sides. Pronotum broad, subpentagonal, broader in front than behind, its median anterior border produced as a rounded angle over the neck, its sides expanded as aliform, feebly reflected plates, bluntly rectangular in front and behind. Mesonotum much narrower

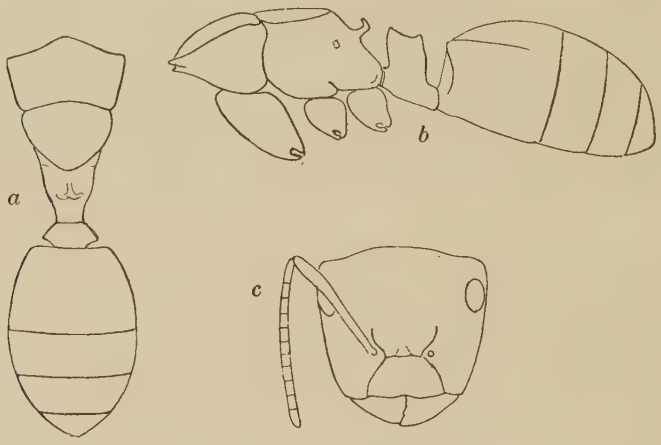

Fig. 27. *Camponotus toussainti* sp. nov. Worker. a, dorsal view of body; b, profile of body; c, head.

than the pronotum, subtriangular, as long as broad, its anterior border evenly rounded, its sides strongly margined and feebly rounded, meeting behind in a blunt, margined point where the mesoëpinotal suture should be located. Epinotum obliquely sloping, distinctly concave, bearing just above its center an unpaired process which is directed backward and upward and bifurcates at the tip to form two branches which are as long as the unpaired basal stem and slightly recurved and blunt at their tips. Petiole nearly twice as broad as long, broader than the epinotum, seen from above trapezoidal, broader behind than in front, its anterior border perfectly straight, transverse and margined, its sides also straight and sharply margined and forming perfect obtuse angles with the anterior border, behind continued into short, pointed teeth. The posterior border is rounded in the middle and sinuately excised on each side. The upper surface is flattened like the pro- and mesonotum. In profile the petiole is about as long as high, subcuboidal, a little higher in front than behind and thicker above than below. Gaster rather large, elliptical, somewhat flattened

dorsoventrally, the anterior and lateral borders of the first segment strongly marginate. Legs moderately stout, fore femora not incrassated.

Opaque throughout, densely and uniformly punctate, the punctures on the gaster being finer than those on the head, thorax and petiole, and the scapes and legs still more finely punctate. Pleuræ also feebly longitudinally rugulose.

Hairs and pubescence white; the hairs short, moderately coarse, pointed, erect and rather uniformly abundant on the head, thorax and gaster, shorter and oblique on the legs, absent on the scapes. Pubescence very coarse, long, appressed, silvery, conspicuous on the head, thorax and gaster but not dense. Scapes and funiculi covered with very short, fine, rather dense pubescence.

Black; antennæ, tibiæ and tarsi dark red.

Described from several specimens taken at Petionville and in the mountains north of Jacmel, running on leaves. The nests could not be found. This species, which is dedicated to the San Domingan patriot Toussaint L'Ouverture, is closely related to *C. saussurei* of St. Thomas, which Forel styled "le bijou du genre *Camponotus*," but the Haitian species is even more remarkable, because its petiole has such an extraordinary shape. The similarity between the two species is closest in the structure of the head and thorax as shown by comparison with Forel's description and figure (Études Myrmécologiques en 1879. Bull. Soc. Vaud. Sc. Nat., XVI, 1879, p. 103, fig. 3).

(*Continued from 4th page of cover.*)

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(*Continued on 2d page of cover.*)

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(*Continued on 3d page of cover.*)

SOME ACALYPTRATE MUSCIDÆ.

By A. L. MELANDER.

[Reprinted from Psyche, Vol. XX, No. 5.]

SOME ACALYPTRATE MUSCIDÆ[1]

By A. L. Melander

By an interesting coincidence Mr. J. R. Malloch, then of the United States National Museum, and I made an independent study of the small flies grouped about the Agromyzidæ. Mr. Malloch's paper on the genus *Agromyza* is to appear in the September issue of the Annals of the Entomological Society of America, while his discussion of the other genera is to come out in the Proceedings of the National Museum. The first installment of my paper was printed in the September issue of the Journal of the New York Entomological Society, which was received at the Bussey Institution, through the mails, on September 8. The remainder of this article, dealing with the Geomyzinæ is to appear in the December issue of that publication.

The following notes were made on a recent visit to the National Museum and to the Philadelphia Academy of Science, and are

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 73.

given as a supplement to my paper. While in Philadelphia I saw the proof sheets of Mr. Malloch's work, and while in Washington I examined his types.

1. *Scutops* Coquillett is not a Geomyzine. The post-vertical bristles are strongly divergent; the costa is nowhere fractured; the palpi are broadly spatulate; the first vein ends at the middle of the wing and the auxiliary vein, although rudimentary, is separated from the first vein, abruptly turning forward so as to terminate near the middle of the costal cell. In addition, the lack of oral vibrissæ, the presence of the clypeus, the single pair of reclinate fronto-orbital bristles, the stiff bristles of the front femora, the absence of preapical tibial bristles; and the shortened anal vein, support its relationships with the Lonchæinæ. The center of the face is broad and flat, obliterating the facial orbits below the antennæ. The face continues on the sides so as to line the mouth-opening; the cheeks thus consisting of the face, genæ and buccæ.

2. *Pseudiastata* Coquillett belongs with the Drosophilinæ. It possesses the following characters which are at variance with typical Geomyzinæ. The costa is fractured both at the humeral crossvein and at the end of the auxiliary vein, where there is a pronounced costal spine; the discal cell is confluent with the second basal; the single frontal bristle is proclinate; there are no mesopleural bristles; and the antennæ are spaced apart.

Mr. Coquillett was apt to over-stress some certain character, such as the vestiture of the arista, and as he relied much on his analytical keys, the microscopic pubescence of the arista of *Pseudiastata* led the genus to the Geomyzinæ. A similar instance occurred with *Sinophthalmus*, which presents more Drosophiline characters than it does Geomyzine. *Pseudiastata* has the anal cell present; the calypteres ciliate; the post-vertical bristles convergent; the oral vibrissæ present; the clypeus visible and moderately developed; the cheeks consisting of the genæ, buccæ and the sides of the face; the center of the face broad and flat; the front pubescent; and the propleural bristle lacking.

3. Spilochroa punctipennis, sp. nov.

Male. Length 2.5 mm. Cinereous, black; body not spotted. Cheeks, face and frontal orbits white-pollinose. Antennæ brown, the third joint blackish,

except near the arista; arista with very short and close pubescence. Proboscis blackish, palpi whitish. Chætotaxy as in *ornata*, the bristles long and strong: two fronto-orbitals; ocellars almost reaching the root of the antennæ; postverticals moderately long and cruciate; oral margin of the narrow cheeks with a row of five hairs, with a strong vibrissa and with a strong bristle in back; five dorso-centrals, four rows of acrostichals with about a dozen setulæ in each; one humeral; two notopleural; three supra-alar; four scutellar; one mesopleural and two sternopleural, as well as a few mesopleural and sternopleural setulæ. Abdomen setulose as in *ornata*, and with an indication of a brownish median stripe. Halteres and calypteres white, the latter with a weak white fringe. Posterior legs yellowish, front coxæ dull whitish, remainder of the front legs blackish. Wings mostly hyaline, but marked with about two dozen pale brown spots, the largest of which occur at the end of the first vein, in the tip of the marginal cell and on the posterior cross-vein. The spots are aggregated in the same general pattern as in *ornata*, but are not nearly so confluent as in that species.

The type, collected by Professor T. D. A. Cockerell at Pecos, New Mexico, July 26, is in the National Museum. Two paratypes were taken by H. S. Barber at Las Vegas Hot Springs, New Mexico, August 11 and 18.

4. Trixoscelis fumipennis, sp. nov.

Male. Length 2.5 mm. Very close to the European *T. marginella* Fallen, but differs in that the paler portion of the first and second posterior cells is not oval in outline.

Head and thorax, largely brownish-gray pollinose; front except the orbits and the rounded ocellar triangle testaceous; orbits at the antennæ reddish; face and cheeks white-sericeous; cheeks two-thirds the eye-height; antennæ reddish, the third joint largely dusky above; arista black, its pubescence microscopic; palpi yellow, proboscis reddish. Ocellar bristles reaching to the base of the antennæ. Thorax with a median brown stripe and with less evident brown vittæ bearing the dorso-central bristles; humeri and pleuræ reddish, becoming paler below; center of the scutellum a trifle darker than the sides: abdomen shining black. Coxæ, front tibiæ and posterior legs testaceous; front femora and tarsi blackish. Halteres and calypteres white. Wings largely darkly infumated, but the base, including the auxiliary cell, a narrow streak in the submarginal cell above the anterior cross-vein, the anterior portion of the discal cell, a middle stripe in the first posterior cell extending to the wing-tip, the greater part of the second posterior cell, and the anal angle, nearly hyaline; costal spines black; anterior cross-vein slightly beyond the middle of the discal cell; sections of the fourth vein proportioned three to four, of the fifth vein six to one; posterior cross-vein slightly longer than the outer section of the fifth vein.

Five specimens: Aweme, Manitoba, N. Criddle, collector, June 12, 1911. The type is in the collection of the Philadelphia Academy of Science, number 6018. Paratypes are in the collections of Mr. Criddle and myself.

Malloch[1] has described the Arizona specimens of *costalis* Coquillett as *claripennis*. This is the species I have designated as *frontalis* Fallen, which is common throughout the Pacific states. Hendel's *Trixoscelis prima* is the same as *Parodinia cinerea* Coquillett.

5. *Hemeromyia* was described by Coquillett as near *Agromyza*. It proves to be the same as the Milichiine genus I described as *Paramadiza*. Malloch's species *Hemeromyia nitens* is the same as my *washingtona*. Curiously enough the name *Paramadiza* was selected also by Malloch, as a new generic name for *Madiza halteralis* Coquillett. As the name *Madiza* is now used for the Chloropine genus *Siphonella* Macquart, the species *halteralis* is without a generic name. (See Malloch, Canad. Entom., xlv., p. 177. June, 1913.) I would therefore suggest the appropriate name *Mallochiella* for this insect and for its European congeners. The identity of the Paramadizas may now thus be tabulated.

MALLOCHIELLA nomen novum.
halteralis Coquillett
Desmometopa (Coquillett)
Madiza (Hendel, Melander)
Paramadiza Malloch
HEMEROMYIA Coquillett.
obscura Coquillett
washingtona Melander
Paramadiza Melander
Syn: *Hemeromyia nitens* Malloch

Fig. 1. *Mutiloptera apicalis* Coq., wing.

6. *Mutiloptera apicalis* Coquillett. This is a curious fly, whose body characters are evidently Geomyzine. The entire posterior portion of the wing is aborted as shown in the sketch.

September 19, 1913.

[1]The Genus *Parodinia* Coq. (Geomyzidæ). Malloch, J. R. Ent. New, xxiv. 274–276 (June, 1913).

[Reprinted from JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, Vol. XXII, No. 1, March, 1914.]

ANTS COLLECTED BY W. M. MANN IN THE STATE OF HIDALGO, MEXICO.[1]

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During the spring and summer of 1913, Mr. M. W. Mann, of the Bussey Institution, was able, through the kindness of Mr. B. Preston Clark, to make an extensive collection of insects in the state of Hidalgo, Mexico. Considerable attention was devoted to the ants and myrmecophiles, as no one seems to have collected these in Hidalgo, though this state is at no great distance from the Mexican capitol. At any rate, I fail to find a single ant cited from Hidalgo in

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 74.

Forel's volume on the Formicidæ in the "Biologia Centrali-Americana." Hence it is not surprising that Mr. Mann's collection should prove to be of unusual interest. All of the specimens were taken at altitudes above 7,000 ft., as will be seen from the following brief notes on the localities in which he collected:

Pachuca. The capitol of the State of Hidalgo, at an altitude of 8,000 ft., situated among low hills, on the slopes of which, in the immediate vicinity of the town, many specimens were taken. The territory is arid, with abundant cacti; in the hollows there are many pepper trees (*Schinus molle*).

Guerrero Mill. This locality is cited for ants taken within a radius of a couple of miles of an ore mill situated on the eastern slope of the high mountain range east of Pachuca. The altitude of the territory over which collections were made, varies from 8,500–9,000 ft. The country is wooded, with oaks and pines predominating. In many of the deeper canyons moisture prevails throughout the year, but the hillsides at times become very dry.

San Miguel. This locality denotes a stretch of semi-plain country, stretching from Velasco (about two miles below Guerrero Mill and at an altitude of about 8,000 ft.) to the eastward. The little village of San Miguel at an altitude of about 7,000 ft. is approximately in the center of the country in which the collections were made. In general the land is rolling, with large, level, semi-arid tracts. A barranca opens into the plain directly from the tropics of the "tierra caliente."

The collection is very interesting in the following respects:

1. Though made at rather high elevations, it comprises a long series of new forms, *e. g.*, a new legionary ant (*Eciton manni* n. sp.), a new *Monomorium* (*M. cyancum* n. subsp.), with metallic blue workers, a new *Pheidole* of the subgenus *Allopheidole* (*Ph. centeatl* n. sp.), with polymorphic workers, a new *Stenamma* (*S. manni* n. sp.), closely allied to the other species of this genus, hitherto known only from subboreal America and Eurasia, a new *Myrmica* (*M. mexicana n. sp.*), related to *M. punctiventris* Roger of the Atlantic States and *M. sulcinodis* Nyl. of Europe, a singular *Leptothorax* (*L. manni* n. sp.), two interesting *Formicæ* (*Formica subcyanea* n. sp. and *nahua* n. var.), a new amazon ant (*Polyergus montezuma* n. var.), a dark variety of one of the honey ants (*Myrmecocystus melanoticus* n. sp.), a new *Lasius* of the subgenus *Acanthomyops* (*L. mexicanus* n. subsp.), and a new *Camponotus, C. pellarius* n. sp. allied to *C. chilensis.*

2. Thirty-four of the thirty-nine forms enumerated in this paper, or 87 per cent. nest under stones. The exceptions are the two species of *Myrmecocystus* and *Pogonomyrmex barbatus,* which make crater nests in the ground, *Pseudomyrma flavidula,* which nests in hollow twigs and *Camponotus nitidus,* which lives in wood.

3. Equally striking is the pronounced melanism, which in a large proportion of Hidalgo ants is not only very apparent in the males and females, but extends also to the workers. This phenomenon is observable in fully twenty-nine, or 74 per cent. of the forms. The only ones in which a decided increase of pigmentation is not apparent in the worker phase, are *Odontomachus clarus, Ponera inexorata, Eciton cœcum, Pseudomyrma, flavidula, Solenopsis minutissima, Pogonomyrmex barbatus, Lasius mexicanus* and *Formica nahua.* In four of these, the species of *Ponera, Eciton, Solenopsis* and *Lasius,* the worker, as shown by the vestigial eyes and pale coloration, is hypogæic in habit. The absence of melanism in the few remaining species is not so readily explained, but is also probably associated with peculiarities of habit.

Undoubtedly this pronounced melanism in the ants of Hidalgo is due to the intensive and protracted insolation to which they are subjected at the high altitudes in which they live. The same peculiarity has been noticed in alpine insects in Mexico and other parts of the world, in mollusks, birds and mammals. Herrera and Lope call special attention to it in their voluminous work on the plants and animals of the Mexican plateau.[2]

It is interesting to note that Mr. Mann, who is preparing a paper on the Hidalgo myrmecophiles notices a high degree of melanism in some of these, especially in a species of *Xenodusa* (*X. sharpi*) and in two other Staphylinids of the genera *Dinardilla* and *Apteronina,* which live with *Liometopum apiculatum,* itself a melanistic, subalpine species.

4. Still another peculiarity, which has impressed me while working on the Hidalgo ants, is the great length of the wings in the females, especially when these have large heavy bodies, as in the genera *Pheidole, Lasius, Camponotuus,* etc. Of course nearly all heavy bodied female ants have long wings, to facilitate the nuptial flight, which not only serves to unite the sexes from different nests, but is of very great

[2] Herrera, A. L., and D. Vergara Lope, La Vie sur les Hauts Plateaux. Mexico, I. Escalante, 1899, 790 pp., 111 plates, 19 tables.

importance in distributing the species over considerable land areas. Now comparison of specimens of closely allied species or of the same species from high altitudes and sea-level shows that the mountain forms have distinctly longer wings. To take only one common example, females of *Lasius niger L.* var. *americanus* Emery from Wisconsin and Illinois have the fore wings only 7.5–8.5 mm. long, whereas these appendages in females of the same size and weight from altitudes of 7,000–8,000 ft. in Colorado measure 9.5–10.5 mm. This enlargement of the wing membranes in mountain ants, which I shall consider in more detail in a later publication, is most readily explained as an adaptation to flight in a more rarified atmosphere. It seems not to have been observed in other insects, probably because the enlargement is slight, amounting only to one or two millimeters or to a fraction of a millimeter. One would expect the rarified atmosphere of great elevations also to have the reverse effect on certain heavy bodied insects and to lead to the suppression of flight and its organs altogether. This seems to be actually the case in some alpine beetles, as has been observed by several authors. One might be tempted to explain the aptery of two of the Hidalgo ants (*Monomorium cyaneum* and *M. compressum*) as the result of such an adaptation, were it not that such females occur in several species of this genus (*e. g., M. ebeninum* Forel and *M. floricola* Jerdon.) that live only at low altitudes in tropical or subtropical countries.

Family **FORMICIDÆ.**

Subfamily PONERINÆ.

1. Ponera inexorata Wheeler.

A single deälated female from San Miguel.

2. Ponera trigona Mayr var. opacior Forel.

Three workers from Guerrero Mill.

3. Odontomachus hæmatoda L. subsp. clarus Roger.

Numerous workers, a deälated female and a male found nesting in the soil under stones at San Miguel.

Subfamily DORYLINÆ.

4. Eciton cœcum Latr.

Numerous workers and males from Guerrero Mill. The latter were taken at lights.

5. Eciton (Acamatus) sumichrasti Norton.

Many workers from several colonies at San Miguel, Pachuca and Guerrero Mill. One large colony was occupying a temporary nest in a bunch of dead cactus.

6. Eciton (Acamatus) melanocephalum Emery subsp. xipe new subspecies.

Worker.—Length 3–5.5 mm.

Differing from the typical *melanocephalum* only in the following characters: The petiole is nearly twice as long as broad, instead of only slightly longer than broad, the thorax and petiole are dark brownish red, instead of light ferruginous red and the head, except the clypeus, the postpetiole and gaster are black, instead of piceous.

Numerous specimens were taken at San Miguel from a single colony in the act of plundering a nest of *Pheidole vasliti* Pergande var. *acolhua* var. nov.

7. Eciton (Acamatus) manni new species.

Worker.—Length 3–4.5 mm.

Allied to *E. melanocephalum*. Head somewhat longer than broad, broader in front than behind, with broadly and feebly excised posterior border and angular posterior corners. Eyes very small and indistinct. Mandibles in the largest workers with oblique blades furnished with two or three small, widely separated teeth, in the small workers toothless and not oblique. Antennæ stout, the scapes only about three-fifths as long as the head. Thorax shaped as in *melanocephalum*, long, narrow, laterally compressed; pronotum with a transverse carina anteriorly, pro- and mesonotum feebly convex above and twice as long as the epinotum, the base of which is straight, horizontal and lower than the mesonotum, separated from it by a shallow but distinct impression, and scarcely longer than the declivity which is slightly concave. Petiole in profile longer than high, evenly convex above, with a small anteroventral tooth; seen from above it is fully twice as long as broad, with parallel sides; postpetiole slightly broader and shorter than the petiole, a little longer than broad, broader behind than in front, with rather straight sides, convex upper surface and a small, blunt, anteroventral tooth. Gaster and legs of the usual shape. Claws simple.

Mandibles subopaque, finely striate and coarsely punctate; head shining, its upper surface in large workers coarsely and sparsely punctate, its lateral and gular surfaces glabrous. Thorax subopaque, finely and densely punctate-rugulose, except the sides of the pronotum, which are very shining and either smooth or very superficially punctate. In the largest workers the inferior meso- and metapleuræ are also somewhat shining and the same is true of the pronotum in all specimens, although this region is as deeply and densely punctate-rugulose as the meso- and epinotum. Petiole finely punctate-rugulose, upper surface of node slightly shining; postpetiole smoother and more shining,

except its ventral surface, which is opaque and finely punctate. Gaster and legs smooth and shining, with small scattered, piligerous punctures.

Hairs pale yellowish, erect, unequal in length, moderately long and abundant, covering the whole body and appendages.

Head and gaster black, front of head and remainder of body dark red; mandibles, middle portions of antennal scapes and of the femora and tibiæ darker and almost black, posterior borders of gastric segments reddish.

Described from several specimens taken from a temporary nest under a stone at Guerrero Mill. This species is readily distinguished from *melanocephalum* by its much shorter antennal scapes, the coarse puctuation of the dorsal surface of the head in the large worker, the longer petiole and smooth sides of the pronotum in all the workers.

Subfamily MYRMICINÆ.

8. Pseudomyrma flavidula F. Smith.

Workers, males and winged females taken from a colony nesting in a grass-culm at San Miguel. These belong to the larger, typical form of the species.

9. Monomorium minimum Buckley.

Several workers and deälated females from Guerrero Mill agree very closely with Texan specimens of this form, which should be regarded as a distinct species and not as a variety of *minutum* Mayr. I find that the teeth on the clypeus and the ridges into which they are continued, are much more prominent in both the females and workers of *minimum* than they are in topotypes of *minutum* from Venice, Italy. Moreover the famale of *minimum* is winged and has the head subopaque, finely longitudinally striated in front and coarsely punctate above, whereas the corresponding phase of *minutum* is apterous and its head is shorter, more shining, more feebly striated and its punctures much smaller. The thorax of the female *minutum* is distinctly smaller and more slender and the petiolar and postpetiolar nodes much narrower and of a different shape, the petiole being epedunculate, whereas it is distinctly pedunculate in *minimum*. The peduncle of the petiole is very short also in the worker of *minimum*. Besides the two following subspecies what I have called the subsp. *ergatogyna* from Santa Catalina Island, Cal., should also be attached to *minimum* and not to *minutum*. Both of these species differ from *carbonarium* F. Smith and its subsp. *ebeninum*

Forel in the shape of the epinotum, as Forel has shown. In the two former species it is sloping and rounded and not cuboidal. *Minutum* and *minimum* nest in the ground under stones, *carbonarium* and *ebeninum* in the cavities of plants (twigs, under bark, between the overlapping leaves of Tillandsias, etc.).

10. Monomorium minimum subsp. cyaneum new subspecies.

Worker.—Differing from the worker of the typical form in coloration, the body being deep, metallic blue; the antennæ and legs black, with the bases of the funiculi, mandibles, mouthparts, tarsi and articulations of the legs piceous.

Female.—Apterous, but with the thorax shaped very much as in the typical *minimum* though distinctly smaller and more slender. Head more shining above. Body and legs black, the latter with yellow articulations and tarsi.

Described from numerous workers and females taken at Guerrero Mill under stones in rather damp places on the sides of canyons.

11. Monomorium minimum subsp. compressum new subspecies.

Worker.—Indistinguishable from that of the typical *minimum*.

Female.—Smaller, less than 3 mm. long; apterous and more worker-like in the structure of the thorax than the subsp. *cyaneum* and *ergatogyna* Wheeler, the mesonotum and scutellum very small. Moreover the thorax is distinctly constricted both dorsally and laterally just in front of the epinotum. The mesoëpinotal suture is deep, the epinotum rather swollen, longitudinally impressed in the middle and in profile shaped like that of the worker. Head rather short, more shining than in the typical *minimum* and the punctures smaller than in this form and in *cyaneum*; petiole narrower. Pilosity white, much shorter and very much sparser.

Described from four females and several workers taken at San Miguel beneath a stone. This may be a distinct species, but its exact position can hardly be determined till its male and those of the allied forms have been carefully studied.

12. Solenopsis picea Emery.

A dozen workers taken from nests under stones at Guerrero Mill are referable to this form, which was originally described from Costa Rica.

13. Solenopsis minutissima Emery.

Several workers from a rather large colony found nesting under a stone at San Miguel agree very closely with some Argentine cotypes of this species given me by Dr. F. Silvestri. One of the workers is larger and has larger, distinctly pigmented eyes, but is probably

an unusual specimen. Three deälated females accompanying these workers measure a little more than 3 mm. and are rich chestnut brown, with yellow legs and antennæ. The upper surface of the head and anterior portion of the mesonotum are coarsely and sparsely punctate. The petiolar and postpeliolar nodes are of subequal width, but the latter is proportionally shorter and fully twice as broad as long. The postpetiole bears a small but prominent tooth on its ventral surface. The gaster is long and narrow.

14. Cremastogaster lineolata Say subsp. opaca Mayr.

Several workers taken from colonies nesting under large flat stones at San Miguel agree very closely with Mayr's description of the typical form of this subspecies. They are very dark in color and lack the denticles which occur on the petiole in *dentinodis* Forel, a form which I took many years ago at Queretaro, Mexico. Several males, accompanying the workers from San Miguel, measure about 3.5 mm. They closely resemble the male of the typical *lineolata* of the Northern States in form, sculpture and pilosity, but are somewhat darker.

15. Pheidole chalca new species.

Soldier.—Length 2.5–3 mm.

Allied to *Ph. floridana* Emery. Head subrectangular, a little longer than broad, with straight, parallel sides and rounded posterior lobes, separated by a deep excision, and with a distinct median dorsal groove continued forward as far as the frontal area. Mandibles convex, with two blunt apical teeth. Clypeus concave and carinate in the middle, its anterior border feebly notched in the middle. Eyes rather large, flat, at the anterior third of the head. Frontal area distinct. Frontal carinæ rather long, forming the mesial borders of very feeble but distinct impressions for the antennal scapes. Antennæ slender, scapes reaching only a short distance behind the eyes; funicular joints 2–8 small, not longer than broad. Thorax robust, shorter than the head and through the humeri more than half as broad. In profile the pro- and mesonotum form a single convex mass, the mesonotum angular and falling rather abruptly behind to the epinotum which is small and has a subequal base and declivity, the latter sloping, the spines small, acute, suberect, longer than broad at their bases. Petiole nearly twice as long as broad, a little broader behind than in front, with concave sides; in profile with both anterior and posterior slopes of the node concave, the node transverse and with rather sharp, feebly notched superior border. Postpetiole nearly 1½ times as broad as the petiole, distinctly broader than long, with its sides in the middle distinctly angular but not conulate. Gaster much smaller than the head.

Whole body shining; mandibles sparsely but not coarsely punctate. Sides

of the clypeus and anterior ¾ of head above, except the flattened areas for the scapes, longitudinally rugose. Epinotum and pleuræ obscurely rugulose; sides of epinotum and sides and ventral surface of petiole densely punctate. Remainder of thorax and gaster with minute, sparse, piligerous punctures.

Hairs coarse, yellow, moderately long, suberect on the body, shorter and subappressed on the scapes and legs.

Brownish yellow; borders of mandibles, clypeus, gaster, except its base and tip, and head, except the cheeks and posterior corners, brown. In some specimens the upper surface of the thorax also is infuscated.

Worker.—Length 1.5–2 mm.

Head subrectangular, excluding the mandibles as broad as long, with the posterior border feebly excised in the middle. Eyes just in front of the median transverse diameter of the head. Mandibles with about 5 denticles. Antennal scapes reaching the posterior border of the head. Clypeus convex, its anterior border rounded and entire. Thorax like that of the soldier, but the pro- and mesonotum less robust, less convex and more evenly rounded in profile and the epinotal spines smaller. Petiole with entire, rather conical node; postpetiole a little broader than long, broader behind than in front, its sides not angulate.

Head thorax and pedicel covered with small, dense punctures and the front of the head also delicately longitudinally rugulose so that it is subopaque. The thorax and pericel, too, are subopaque, except the upper surface of the pronotum and the nodes which are more or less shining.

Pilosity much as in the soldier.

Color brownish yellow, dorsal surface of the head, thorax and gaster often a little darker.

Female.—Length 4.5–5 mm.

Head subrectangular, as broad as long, a little broader behind than in front, the posterior border nearly straight. Thorax seen from above elliptical, but narrowed in the epinotal region, which is sloping in profile, with stout, short, pointed teeth. Petiolar node emarginate. Postpetiole nearly twice as broad as long, its sides in the middle produced as blunt conules. Gaster broadly elliptical. Wings very long (7.5 mm.).

Mandibles rather shining, coarsely striato-punctate; clypeus and head subopaque, longitudinally rugose and reticulate even on the depressions for the antennal scapes. Pronotum opaque and rugulose. Remainder of thorax shining, but with the sides and dorsal surface coarsely punctate and striate. Petiole and postpetiole less shining than the gaster, with coarse piligerous punctures. Gaster sparsely and minutely punctate, with large punctures on the extreme base of the first segment.

Hairs longer and more abundant than in the soldier.

Dark piceous brown or black; mandibles, except their borders, clypeus, cheeks, legs and bases and tips of antennal funiculi brownish yellow, the middle portions of the tibiæ and femora darker. Wings gray, with pale brown veins and stigma.

Described from numerous specimens taken from many colonies of

rather small size nesting beneath stones at Guerrero Mill. This species is evidently closely related to *Ph. floridana,* but the head of the soldier is larger, less flattened, the thorax is stouter, with smaller epinotal spines, the postpetiole is decidedly narrower and the sculpture is very different both in the soldier and worker. The worker of *chalca,* moreover, is much more robust than that of *floridana* and it various subspecies and varieties, and the pilosity is very different, being like that of the soldier and not consisting of very sparse, feebly clavate hairs on the body.

16. Pheidole ceres Wheeler subsp. tepaneca new subspecies.

Soldier.—Differing from the typical form from Colorado in the darker color of the head, thorax and gaster, which are black and not dark brown, and in the sculpture of the head and thorax, especially the posterior lobes of the former and the pronotum, which are more glabrous and shining. The rugæ on the anterior part of the head are sharper and more nearly straight and the interrugal spaces are finely and densely punctate and much less distinctly reticulate.

Worker and female differing from those of the typical *ceres* also in their darker color and more shining surface.

A few soldiers and females and many workers of this harvesting ant were taken from small colonies under stones at Guerrero Mill.

17. Pheidole (Allopheidole) centeotl new species.

Soldier.—Length 4 mm.

Allied to *Ph. macclendoni* Wheeler. Head very large, including the mandibles fully twice as long as the thorax, longer than broad, rather flat, especially behind, as broad in front as behind, with straight sides and rounded posterior lobes, separated by a deep angular excision and with a pronounced middorsal groove continued forward to the frontal area. Eyes small, rather flat, at the anterior fourth of the head. Mandibles convex, with two blunt apical teeth. Clypeus very short, carinate, with the posterior margin deeply impressed and the anterior margin narrowly notched in the middle. Frontal area small, triangular, rather deeply impressed, with a median carinula. Frontal carinæ short, diverging posteriorly. Antennæ small and slender; scapes reaching only a short distance behind the eyes, terete, slightly curved at the base, funicular joints 2–8 as long as broad. Thorax small, less than half as broad as the head, with bluntly rounded humeri. In profile the pro- and mesonotum form a single convex mass, the mesonotum having a plain surface, without transverse constriction or welt, sloping to the epinotum, which has a subequal base and declivity, the former horizontal, the latter very sloping, armed with two small, erect teeth, which are as long as broad at the base. Petiole from above fully twice as long as broad, with subparallel sides; in profile the node is moderately

high and transverse, with long, concave anterior and short, abrupt, posterior slope, its border entire and evenly rounded. Postpetiole twice as broad as the petiole, decidedly broader than long, with each side produced in the middle as a distinct, pointed conule. Gaster elliptical, much smaller than the head. Legs rather long and slender.

Body shining; clypeus and anterior half of head rather coarsely longitudinally rugose, the spaces between the rugæ feebly reticulate. Mandibles and posterior half of head with scattered, piligerous punctures. Thorax, pedicel and gaster also with similar punctures, but the pleuræ irregularly rugulose and the epinotum subopaque, densely and superficially punctate.

Hairs yellowish, erect or suberect, delicate, moderately long and abundant, covering the body, scapes and legs.

Ferruginous; borders of mandibles, sides of the clypeus, the median longitudinal groove of the head, the mesonotum, epinotum, pedicel and gaster dark brown or blackish.

Mediæ.—Length 2.5–3.5 mm.

Representing a series of intermediates between the soldier and worker in the size and sculpture of the head and in the size and shape of the body.

Worker.—Length 2–2.5 mm.

Head, excluding the mandibles, subrectangular, as broad as long. Mandibles with 5 or 6 denticles. Clypeus rather convex, with entire anterior border. Eyes just in front of the middle of the head, moderately convex. Antennal scapes scarcely surpassing the posterior corners of the head. Thorax like that of the soldier. Postpetiole nearly as long as broad, its sides in the middle distinctly angular, but not produced or conulate.

Shining; anterior half of head and the whole thorax subopaque and densely punctate, the cheeks and front also longitudinally rugose; pronotum smooth and shining above.

Pilosity similar to that of the soldier but shorter.

Black; antennæ and legs piceous; mandibles, bases of funiculi, tarsi and articulations of legs yellowish.

Female.—Length 5.5–6 mm.

Head rectangular, not longer than broad. Eyes rather large and convex. Thorax of the usual shape, with flat mesonotum and scutellum; epinotum sloping, without distinct base and declivity, armed with two short, acute teeth, which are very broad at their bases. Petiole and postpetiole like those of the soldier. Gaster broadly elliptical. Wings very long (10 mm.).

Shining and with sparse, minute, piligerous punctures; mandibles more coarsely punctate; sides of clypeus and anterior ¾ of head subopaque, longitudinally rugose.

Pilosity much as in the soldier but more appressed on the thorax and gaster.

Dark brown; mandibles, except their borders, which are black, clypeus, cheeks, pronotum, pleuræ, antennæ and legs reddish or ferruginous. Wings gray, with pale brown veins and stigma.

Described from many specimens taken from a number of colonies nesting beneath stones on the hill sides at Guerrero Mill. This species differs from *Ph. macclendoni* in its smaller stature and in the head of the soldier, which in the latter species is proportionally shorter, much more convex above and very differently sculptured. I have named it after the Aztec Ceres, or maize goddess, as it is, in all probability, a harvesting species. Owing to the structure of the head and the polymorphism of the worker phase it may be referred to Forel's subgenus *Allopheidole,* which also includes *Ph. macclendoni, tepicana* Pergande and *kingi* Ern. André, the last being the type. *Ph. vasliti* Perg., which Forel also assigned to this subgenus must evidently be excluded. For reasons given below I make it the type of a new subgenus, *Cardiopheidole.* Both of these subgenera, however, seem to be rather artificial and therefore of doubtful value.

18. Pheidole (Cardiopheidole) vasliti Pergande var. acolhua new var.

Soldier.—Differing from the typical form and the var. *hirtula* Forel in its darker color, the gaster, pedicel, pleuræ, epinotum and femora, and in some specimens also the remainder of the thorax and the head, dark brown or black in mature specimens, the cheeks sometimes red or yellowish.

Mediæ and worker.—These are also darker than the corresponding phases of the typical form and var. *hirtula,* the mediæ being piceous or blackish, with red mandibles and cheeks, the worker black, with yellowish mandibles and brownish funiculi, tarsi and articulations of the legs.

Female.—Length 8–9 mm.

Head, excluding the mandibles, subrectangular, a little broader than long, a little broader behind than in front. Anterior clypeal border transverse, flattened, deeply emarginate in the middle. Antennal scapes reaching nearly to the posterior corners of the head, flattened and somewhat incrassated and rather strongly curved at the base. Thorax of the usual shape, with broad, flat mesonotum and sloping epinotum, the latter armed with strong, blunt, laterally compressed teeth. Petiole from above concave on the sides, broadest behind through the node, which is transverse, with a sharp border, excised in the middle and with rather straight sides above. Postpetiole seen from above, about twice as broad as long, with broadly rounded anterior border, its sides in the middle projecting as blunt angles. Gaster broadly elliptical, flattened dorso-ventrally. Wings very long (9–10 mm.).

Mandibles shining, coarsely and very sparsely punctate. Middle of clypeus and a narrow median line on the head shining, sides of clypeus and remainder of head subopaque, coarsely longitudinally rugose, with reticulate interrugal spaces. Thorax and pedicel subopaque, finely striate and coarsely punctate, middle of the mesonotum, anterior portion of scutellum and gaster shining, covered with scattered piligerous punctures.

Hairs on the body sparse, long, erect; on the legs and scapes shorter, more abundant and more reclinate.

Black; mandibles, except their borders, cheeks, antennal funiculi and legs red; femora darker. Wings gray, with yellow veins and brown stigma.

Male.—Length 5–6 mm.

Head very small; cheeks very short; mandibles minute, bidentate; eyes large, half as long as the sides of the head. Antennæ slender; scapes very short, not longer than the second and succeeding joints of the funiculi, first funicular joint subglobular. Thorax robust, nearly twice as broad as the head; mesonotum convex in front, flattened behind; epinotum with subequal base and declivity and a blunt angular projection on each side in the place of the spine. Petiole like that of the soldier, with sharp, emarginate superior border. Postpetiole subcampanulate, broader behind than in front, with feebly rounded sides. Gaster elliptical. Legs very slender. Wings rather broad.

Head, thorax and pedicel subopaque, densely and finely punctate-regulose. Gaster shining, with minute, sparse, piligerous punctures.

Hairs grayish yellow, erect, long and very abundant on the head, thorax and petiole, much sparser on the gaster, shorter and more appressed on the legs.

Black; mandibles and tarsi, except the first joint, yellowish. Wings colored as in the female.

Described from a large number of specimens taken from many colonies at San Miguel, Pachuca and Guerrero Mill. These colonies are often very populous and nest under stones in open, arid situations. There are also in my collection many specimens of this same variety from Saltillo and Guadalajara, Mexico, taken several years ago by Dr. J. F. McClendon.

Great confusion is apparent in the literature in regard to *Ph. vasliti* and certain other forms described by Pergande as *Ph. subdentata* and *obtusospinosa* and by Santschi as *Ph. arizonica.* As I have on hand a considerable number of specimens referable to these forms, I am able to state that Forel has confounded two very distinct subspecies, one of which was originally described by Pergande from Lower California. The worker of the other was described by Pergande as *subdentata* from Tepic, Mexico, and the corresponding soldier from the same locality was described by the same author as *Ph. obtusospinosa.* Finally Santschi described what is nothing more than a dark variety of *subdentata* from Tucson, Arizona as *Ph. arizonica.* I have been able to reach these conclusions from a study of cotypes of *subdentata* and *obtusospinosa* in my collection and numerous topotypes of *arizonica* collected by myself a few years ago in the Santa Cruz River bed at Tucson, Arizona.

The soldiers of the two subspecies and their varieties may be distinguished by means of the following table:

1. Head of soldier cordate, narrowed anteriorly, with slightly concave cheeks and convex front; mandibles without a deep longitudinal impression at the apex between the two teeth; postpetiole fully twice as broad as long ..... 2.

   Head of soldier less narrowed anteriorly and less convex in the frontal region; cheeks not concave; mandibles with an elongate and rather deep, longitudinal impression at the apex between the two teeth; postpetiole not twice as broad as long ..... 4.

2. Color pale brown or reddish, gaster shining; length 3.8–4.4 mm., *Ph. vasliti* Pergande.

   Color darker; gaster subopaque; pilosity more abundant; length 6–7 mm. 3.

3. Gaster black, head and thorax often dark brown or blackish, var. *acolhua* var. nov.

   Color somewhat lighter ..... var. *hirtula* Forel.

4. Color paler ..... subsp. *subdentata* Pergande.

   Color darker ..... var. *arizonica* Santschi.

The synonomy and distribution of these forms is as follows:

Pheidole vasliti Pergande, Proc. Cala. Acad. Sci. (2), V, 1895, p. 883, ♂☿; Forel, Biol. Centr. Amer., 1889–90, p. 65.

Ph. obtusospinosa Forel (*nec Pergande*) Ann. Soc. Ent. Belg. XLV, 1901, p. 130.

Sierra San Lazaro, Lower California (Eisen and Vaslit).

Ph. vasliti var. hirtula Forel, Biol. Centr. Amer. 1889–90, p. 65, ☿♀; Ann. Soc. Ent. Belg. XLV, 1901, p. 130,☿♀; Wheeler, ibid. p. 202, ☿♀.

Durango (Brinkmann); Queretaro (Wheeler); Zapotlan, Jalisco (C. H. T. Townsend).

Ph. vasliti var. acolhua new var.

State of Hidalgo (W. M. Mann); Saltillo and Guadalajara (J. F. McClendon).

Ph. vasliti subsp. subdentata Pergande.

Ph. subdentata Pergande, Proc. Cala. Acad. Sci. (2) V, 1895, p. 888, ☿.
Ph. obtusospinosa Pergande, *Ibid.* p. 889, ☿.

Tepic, Mexico (Eisen and Vaslit); Rio Santiago (J. F. McClendon).

Ph. vasliti subsp. subdentata var. arizonica Santschi.

Ph. arizonica Santschi, Bull. Soc. Ent. Ital. XLI, 1909, p. 3, ☿.

Tucson, Arizona (F. Silvestri); Bed of Santa Cruz River, Tucson (Wheeler); Huachuca Mts., Arizona (Wheeler and W. M. Mann).

Ph. vasliti is certainly much more closely related to the series of forms embracing *Ph. texana* Wheeler, *hyatti* Emery, *crassicornis,* Emery, etc. than to *Ph. kingi, rugifrons,* etc. This latter group is much more closely related to our typically nearctic series of Pheidoles, including *Ph. pilifera* Roger, *vinelandica* Forel, etc. Hence I am unable to follow Forel in including *vasliti* in the subgenus *Allopheidole,* merely because it possesses polymorphic, instead of dimorphic workers. In order to emphasize this conclusion I have placed it in a distinct subgenus.

19. Stenamma manni new species.

Worker.—Length 2.5–3.5 mm.

In the shape of the body very much like *S. westwoodi* Westwood and *brevicorne* Mayr, but the eyes are much larger and the basal joint of the funiculi a little longer and less transverse. Sculpture of the head, thorax and pedicel a little finer and more as in the subsp. *diecki* Emery of the latter species, so that the surface, especially of the pronotum and posterior portion of the head, is somewhat shining. Pilosity much as in the other species of the genus, but the color is very different, being black, with the tarsi, articulations of the legs, the mandibles and tips of the antennæ, dark red.

Female.—Length 4.2 mm.

Closely resembling the worker, except for the usual sexual differences. Wings distinctly infuscated, with the inner branch of the cubital vein arising from the cubital cell a short distance proximal to the cross-vein. The venation is therefore intermediate between that of *S. nearcticum* Mayr and *westwoodi* on the one hand and *brevicorne* on the other, since in the two former species the inner branch of the cubital arises at a point just distal to the cross-vein, whereas in the latter it arises from the middle of the cubital cell. The veins and sitgma are, moreover, dark brown in color, but very pale in *nearcticum* and *brevicorne* and only slightly darker in *westwoodi.*

Described from two females and 13 workers taken from a couple of colonies, which were nesting under large stones in a damp spot in the pine forest on the trail between Real del Monte and El Chico at the summit of the range (10,000 to 11,000 ft.).

20. Pogonomyrmex barbatus F. Smith.

Several workers, three males and a deälated female from Pachuca are referable to this form. The workers measure 5.5–6 mm., and are

distinctly smaller and perhaps a little darker than the workers of the var. *molefaciens* Buckley from Texas, but the male has the head, thorax and node of the petiole black, whereas these parts are reddish yellow like the rest of the body in *molefaciens*. Moreover the wing-veins and stigma are brown and not resin yellow as in the Texan variety. In the female the epinotal spines are as long and slender as in the worker, but in *molefaciens* they are very short and broad at the base. The color of this sex is the same as that of the female *molefaciens*.

At Pachuca *P. barbatus* inhabits large, flat, crater nests about 4 feet in diameter in the open, arid country.

21. Myrmica mexicana new species.

Worker.—Length 3.5–5 mm.

Closely allied to the European *M. sulcinodis* Nyl. Head distinctly longer than broad. Antennal scapes shaped like those of *sulcinodis* or rather of the var. *sulcinodis-scabrinodis* Forel, being a little more sharply bent at the base and in some specimens with a small tooth or ridge at the angle as in some forms of *scabrinodis*. The joint is of nearly uniform thickness throughout. Funiculi with a 3-jointed club, which in some specimens, seems to be indistinctly 4-jointed. Spines of the epinotum straight or very slightly bent downward, somewhat shorter than those of *sulcinodis* and not recurved at their tips. Petiole in profile a little longer than high, shaped as in *sulcinodis*, not pedunculate, its node with subequal declivities, the anterior feebly concave, the posterior feebly convex, both meeting at a rather sharp angle. Postpetiole also as in *sulcinodis*, distinctly higher than long.

Sculpture very coarse and much as in *sulcinodis*, with shining interrugal spaces, but the longitudinal trend of the rugæ is not so distinct on the thorax and pedicel, often vermiculate on the thoracic dorsum and the nodes. Frontal area rugose, opaque.

Hairs like those of *sulcinodis*, but of a gray instead of a yellow tint.

Deep cherry red, legs a little darker; gaster, clypeus and anterior half of head, black. In many specimens the whole head and thorax are dark brown or blackish.

Female (deälated).—Length 5.5 mm.

Closely resembling the worker and differing greatly from the female *sulcinodis* in color, being like the darkest workers, with the upper surface of the thorax and the whole head blackish.

Male.—Length 5–5.5 mm.

Differing from the male of *sulcinodis* in its larger size and in color, the body being deep black, with only the legs and genitalia piceous, and the 4-jointed clubs of the antennæ and tips of the mandibles clear yellow. The wings are more grayish and longer (6 mm.), whereas those of *sulcinodis* measure

less than 5 mm., and the veins and stigma are of a deeper brown tint. The antennal scapes resemble those of *sulcinodis,* being fully half as long as the funiculi, but are somewhat stouter, especially at the base. There are no appreciable differences in pilosity between the two forms. In sculpture the following differences may be noted: the petiolar node is irregularly rugulose-punctate, not longitudinally rugose as in *sulcinodis,* and the postpetiole is also smoother and more shining; the fine rugæ on the head are more irregular and not longitudinal.

Described from many workers and males and three females taken from several colonies at Guerrero Mill. These colonies were found under stones both in the pine woods and on open hill-sides. The status of this form is somewhat doubtful, as one may be inclined to regard it as a subspecies of *sulcinodis.* It is certainly singular that it should be more closely related to the European *sulcinodis* than to any of the nearctic Myrmicas, except *M. punctiventris* Roger. Even *M. brevinodis* Emery, although it has varieties (*subalpina* Wheeler and *sulcinodoides* Emery) that approach the European form in sculpture and color, differs considerably from *sulcinodis* in the antennal scapes of the worker and male. The Mexican form is closely related to *M. punctiventris* of the Eastern States. In the worker of this species, however, the petiole is pedunculate and has a larger antero-ventral tooth, the epinotal spines are shorter, the antennæ are less angularly bent at the base and the gaster is coarsely punctate. The male *punctiventris* is much smaller than that of *mexicana,* but in other respects remarkably similar.

22. Leptothorax manni new species.

Worker.—Length 2–2.2 mm.

Head subrectangular, longer than broad, with broadly rounded posterior border. Mandibles 5-toothed. Clypeus convex, its anterior border very feebly and sinuately emarginate in the middle. Frontal area distinct. Antennæ 12-jointed; scapes reaching very nearly to the posterior border of the head; first funicular joint as long as joints 2–5 together; joints 2–6 a little broader than long, 7 and 8 as long as broad; terminal longer than the two penultimate joints of the 3-jointed club. Thorax flattened above and on the sides, a little narrower behind than in front, not constricted when seen from above and without impressed sutures on the dorsal surface, which, therefore, in profile is perfectly even and nearly straight. Humeri rather prominent, subangular; base and declivity of epinotum in profile subequal, the latter sloping, armed with two small, suberect teeth, which are not longer than broad at their bases. Petiole subpedunculate, seen from above pyriform, broader behind than in

front, about 1½ times as long as broad; in profile the anterior and posterior declivities of the node are subequal, the former straight or very feebly concave, the latter convex. Postpetiole nearly half again as broad as the petiole, broader than long, subrectangular, with rounded anterior corners. Gaster elongate elliptical, with feebly excised anterior border. Femora slightly swollen in the middle.

Mandibles subopaque, coarsely striatopunctate. Cheeks, pleuræ, epinotum, petiole and postpetiole subopaque, finely and densely punctate; cheeks and clypeus also delicately longitudinally rugulose; remainder of body very smooth and shining, finely and very sparsely punctate, especially the posterodorsal portion of the head, the pronotum and the gaster.

Hairs snow white, short, delicate but clavate, sparse and erect on the body; on the appendages very minute, appressed and pointed.

Black; antennæ and legs deep red or piceous, scapes and middle portions of femora and tibiæ darker. In some specimens the tarsi and articulations of the legs are more yellowish.

Female.—Length 3–3.5 mm.

Differing from the worker in the following particulars: Head broader and somewhat more rectangular. Thorax large, subelliptical from above and flattened dorsally, the mesonotum large, the base of the epinotum only half as long as the declivity, which is abrupt and concave. Petiole in profile with wedge-shaped node, its anterior slope short and slightly concave, its posterior slope straight and perpendicular, its superior border rounded and entire. Postpetiole more distinctly rectangular than in the worker, nearly twice as broad as long, very convex above and in front, depressed behind.

Sculpture much as in the worker, but the front of the head longitudinally striated and the nodes of the petiole smoother and more shining.

Pilosity and color as in the worker, except that the hairs on the body are pointed. Wings whitish hyaline, with pale yellow veins and conspicuous brown stigma.

Male.—Length 2 mm.

Head through the eyes as broad as long, semicircular behind. Mandibles small. Antennæ short; scapes only about three times as long as the first funicular joint, which is oval and less than twice as long as broad. Eyes large and prominent. Thorax nearly as broad as long; mesonotum convex; epinotum depressed, sloping and unarmed. Petiole and postpetiole like those of the worker; legs more slender.

Whole head subopaque, densely and finely punctate-rugulose. Remainder of body shining; thorax above finely longitudinally striated.

Hairs very short and sparse, pointed.

Color like that of the worker and female. Veins of wings very pale; stigma as in the female, large, dark brown and conspicuous.

Described from numerous workers and females and a single male taken from nests in the ground beneath stones at El Chico and

Guerrero Mill. This species is most closely related to *L. schmitti* Wheeler of Colorado, but the worker is readily distinguished by its much darker color, shorter head, shorted epinotal spines and very different petiolar node. The new species also bears a superficial resemblance to *L. stolli* Forel, known only from the summit of the Volcan de Agua, in Guatemala (13,000 ft.), but the worker of this species is larger (nearly 3 mm. long), has a longer head and the thorax is more rounded and not prismatic.

Subfamily DOLICHODERINÆ.

23. Tapinoma sessile Say.

Numerous workers and deälated females from San Miguel and Guerrero Mill agree very closely with our large, common North American form of this species.

24. Liometopum apiculatum Mayr.

Many workers and two males from Guerrero Mill and Pachuca.

Subfamily CAMPONOTINÆ.

25. Prenolepis (Nylanderia) vividula Nylander.

Several workers from San Miguel.

26. Prenolepis (Nylanderia) mexicana Forel.

Many workers, three females and a single male from nests in the soil beneath stones at Guerrero Mill. The hitherto undescribed female measures 4.5–5 mm. and is very dark brown, with the funiculi, tarsi and articulations of the legs yellowish and the wings rather deeply infuscated, with brown veins and stigma. The pilosity is similar to that of the worker, but the pubescence is gray, rather long and very dense, covering the whole body so that it is opaque and not shining as in the worker.

27. Lasius (Acanthomyops) interjectus Mayr subsp. mexicanus new subspecies.

Worker.—Differing from the worker of the typical form from the United States in its smaller size (only 2.7–3.3 mm., whereas the typical *interjectus* measures 3.5–4 mm.), and in having the long hairs on the body somewhat finer and less flexuous.

Female.—Not darker than the worker and much smaller than the typical form (length 4.5–5 mm. as compared with 6.5–7 mm. in the true *interjectus*),

with much shorter and fewer erect hairs on the thorax and gaster, with long, distinct pubescence on the mesonotum, which is glabrous and without pubescence in the type. The pubescence on the gaster is also much denser so that it nearly conceals the surface. Wings paler, with paler veins and stigma, and proportionally longer, measuring 7 mm., compared with 7.5 mm. in the typical *interjectus*.

Male.—Also smaller than the corresponding sex of the typical *interjectus* (3 mm.). Body darker and more opaque, much less hairy, but with more abundant pubescence, especially on the upper surface of the epinotum.

Described from numerous workers, females and males, taken from large colonies near Guerrero Mill. These were nesting beneath large stones, especially in pine woods and at high altitudes. The males and females were captured during May, whereas those of the typical *interjectus* are not found in the United States till later in the summer (from the middle of July till the middle of September).

28. Formica microgyna Wheeler subsp. rasilis Wheeler var. nahua Wheeler.

Workers and females from Guerrero Mill.

A full account of this and the three following Formicas is given in my recent "Revision of the Ants of the Genus Formica (Linné) Mayr," Bull. Mus. Comp. Zool., LIII, 1913, pp. 562 *et seq.*

29. Formica subcyanea Wheeler.

Workers, females and males from Guerrero Mill, Velasco, below Real del Monte; El Chico and Pachuca.

30. Formica rufibarbis Fabricius var. gnava Buckley.

Workers, females and males from Guerrero Mill and El Chico.

31. Formica cinerea Mayr var. altipetens Wheeler.

A few workers from Pachuca.

32. Polyergus rufescens Latreille subsp. breviceps Emery var. montezuma new var.

Worker.—Very similar to the typical *breviceps* of Colorado, but differing in coloration, the general tint of the body being slightly darker and more brownish red, with the legs, the posterior border of the first gastric segment broadly and the succeeding segments entirely fuscous. The pilosity is fully as abundant as in the typical *breviceps*, differing in this respect from *mexicanus* Forel, which is scarcely more than a variety, if indeed it be not a synonym of *breviceps*.

Female.—Colored like the worker, but the general tint of the body even darker. Veins and stigma of the wings also darker than in the female *breviceps*.

Male.—Indistinguishable from the male of the typical *breviceps*.

Described from several workers, a male and a female belonging to a single colony which was taken at Pachuca. The slaves in the nest were *Formica subcyanea* Wheeler.

33. Myrmecocystus mexicanus Wesmael var. melanoticus new var.

Worker.—Differing from the typical *mexicanus* in color, the body being deep fuscous, the gaster nearly black, the legs, antennæ, mandibles, clypeus and cheeks yellowish brown.

Male.—Length 5.5 mm.

Like the male of the var. *hortideorum* McCook, but of a different color, the body being black, the genitalia, antennæ and legs deep fuscous or piceous. The wings are longer (6.5 mm., those of *hortideorum* are less than 6 mm.), without a discal cell.

Described from eight workers and a male taken at Pachuca. This is a very distinct variety, as the worker is much darker in color than in any of the other forms of *mexicanus* and therefore bears a superficial resemblance to the following species.

34. Myrmecocystus melliger Forel.

Several rather small workers taken from small crater nests at Pachuca either belong to the typical form of this species or to a very closely related variety.

35. Camponotus maculatus Fabricius subsp. picipes Olivier.

Many workers, males and winged females from Pachuca, San Miguel and Guerrero Mill, belonging to the common Mexican form of this subspecies which was redescribed many years ago by Forel (Bull. Soc. Vaud. Sc. Nat., XVI, 1879, p. 67). In the workers more or less of the thoracic dorsum, especially in front, is dark brown or blackish. The wings of the female are very long (15–16 mm.). Mr. Mann informs me that this ant is very common throughout the mountains of Hidalgo, nesting in the ground under stones, like other races of *maculatus*.

36. Camponotus maculatus subsp. picipes var. pudorosus new var.

Worker major.—Length 6.5–7 mm.

Differing from the typical *picipes* in its smaller size, in sculpture and coloration. The head is distinctly shining and much more finely and superficially shagreened, and the dorsal surface of both the head and thorax is paler in color. The base of the first gastric segment is yellow like the petiole and legs. The tibiæ of the latter are only a little darker than the femora and therefore much paler than in *picipes*. The pilosity is like that of the subspecific type.

Worker minor.—Length 4.5–5 mm.

Very similar to the worker major in color and sculpture, but the head is pale brown.

Female.—Length about 8.5 mm.

Body smaller, head more shining and more superficially sculptured than in the female *picipes*. Head, thoracic dorsum and the whole gaster black; epinotum, tibiæ and tarsi brown, pleuræ, femora and petiole yellow. Wings long (12.5 mm.), brownish yellow, with resin yellow veins and brown stigma.

Male.—Length 6.5 mm.

Differing from the male of the typical *picipes* only in its smaller size.

Described from numerous workers, a male and female, from nests under stones at Guerrero Mill.

37. Camponotus nitidus Norton var. nuperus new var.

Worker major.—Length 6–6.5 mm.

Head rather small, excluding the mandibles a little longer than broad, a little narrower in front than behind, with rounded sides, posterior border and posterior corners, convex above, with large, flattened eyes situated just behind the median transverse diameter of the head. Mandibles short, with 5 subequal teeth. Clypeus strongly carinate, its median portion as broad as long, with its anterior lobe very short, rounded and entire. Frontal area distinct, large and triangular. Frontal carinæ straight, strongly diverging. Frontal groove distinct, a little longer than the frontal carinæ. Antennal scapes slender, terete, slightly curved at the base and feebly and gradually thickened towards their tips, reaching fully one-third their length beyond the posterior border of the head. Thorax short, laterally compressed, especially behind, feebly and regularly arcuate above in profile, but the epinotum with its straight base forming a rather sharp ridge, shorter than the declivity and making with it nearly a right angle, as the declivity is nearly perpendicular and distinctly concave. Promesonotal and mesoëpinotal sutures pronounced. Petiole small, nearly as broad as the epinotum, but much lower, in profile cuneate, thick at the base, with convex anterior and flat posterior surface and the superior border sharp, entire and evenly rounded when seen from behind. Gaster of the usual shape; legs rather long.

Shining throughout; mandibles densely striato-punctate, smoother at the base; remainder of body smooth and very finely shagreened; clypeus and cheeks with large, shallow, sparse punctures.

Hairs golden yellow, erect, very sparse on the clypeus, front, vertex and gaster, absent on the thorax, petiole and appendages, except at the tips of the scapes and on the knees, where there are a few small hairs. Pubescence extremely fine and dilute, visible only on the pleuræ, epinotum and venter.

Yellow; gaster, posterior portion of head, front, tips of mandibles and clouds on the thoracic dorsum dark brown, posterior borders of gastric segments paler. Antennæ reddish brown. In some specimens the anterior portion

of the head is also brown but of a lighter tint than the portion behind the eyes.

Worker minor.—Length 5–5.5 mm.

Differing from the worker major only in its somewhat smaller size and the somewhat more elongate head, with less convex sides.

Female.—Length 6.5 mm.

Also very much like the worker major, but the head is distinctly longer and narrower and the cheeks are nearly straight. Scutellum with a few erect hairs. Wings very long (9 mm.), slightly infuscated, with brown veins and stigma.

Described from eleven workers and a single female taken at Guerrero Mill from a colony nesting in the trunk of a live oak. I have described this form at length because of the meagreness of Norton's original description of *nitidus* (Proc. Essex Inst. 1868, p. 2) which was based on three minor workers "from the mountains of Orizaba", where the species lives in "little companies under the bark of pines" (Amer. Natur. II, 1868, p. 60). It was more fully characterized by Forel (Bull. Soc. Vaud. Sc. Nat. XVI, 1879, p. 82). The specimens from Hidalgo evidently represent a distinct variety as their thorax is much paler than in the typical form, judging from Norton's description. Comparing them with a few cotypes of *C. montivagus* Forel taken by Stoll at Tecpam, Guatemala (7,000 ft.), I find that the latter is scarcely more than a variety of *nitidus* and not a distinct species as Forel maintained in Biol. Centr. Amer. Formicidæ, 1899–1900, p. 154.

38. Camponotus andrei Forel var. cholericus new var.

Worker major.—Length 6.5–7 mm.

Head more elongate than in the worker major of the typical form and with a deeper impression in the middle of the anterior border of the clypeus. Epinotum distinctly lower and more sloping. Hairs covering the body snow white instead of yellowish. In other respects like the typical form of the species.

Worker minor.—Length 4–4.5 mm.

Closely resembling the corresponding phase of the typical *andrei*, but the epinotum distinctly less angular in profile and more sloping, and the hairs on the body more brilliantly white as in the worker major.

Male.—Length 5 mm.

Resembling the minor worker in sculpture and pilosity, but the body entirely black, including the mandibles, antennal funiculi, tarsi and genitalia. Wings whitish hyaline, with dilute yellow veins and brown stigma.

Described from numerous workers and several males taken at Pachuca in the ground under stones in arid territory. The workers

have been compared with a couple of cotypes kindly given me by Prof. Forel.

39. Camponotus pellarius new species.

Worker major.—Length 7.5–8 mm.

Superficially resembling *C. chilensis* Spinola in color, sculpture and pilosity. Head, excluding the mandibles, as broad as long, broader behind than in front, with straight sides and very feebly concave posterior border. Mandibles rather small, convex, with 6 subequal teeth. Clypeus flattened, feebly carinate, with straight, entire anterior border. Frontal area distinct, broadly triangular. Frontal carinæ sigmoidal, diverging behind. Eyes moderately large and convex. Antennal scapes distinctly flattened at the base, enlarged at their tips, which extend somewhat beyond the posterior corners of the head. Thorax short, rapidly contracted posteriorly, pronotum flattened above, rather broad, with its sides in front distinctly and rather sharply marginate; in profile the outline of the thorax is evenly convex and rounded, the epinotum continuing the curve as this region is uniformly sloping and without distinct base and declivity. Promesonotal suture very distinct; mesoëpinotal suture obsolete, but indicated by an impression on the pleuræ. Petiole nearly as high as the epinotum, compressed anteroposteriorly, with slightly convex anterior and flat posterior surface and blunt, entire, broadly rounded superior border. Gaster rather large, flattened above. Legs moderately long.

Mandibles shining, sparsely punctate; anterior border of clypeus coarsely punctate, remainder of body, including the antennæ and legs opaque, densely punctate.

Hairs rather stout, blunt, snow-white, erect, abundant, moderately long on the body, fore coxæ and lower surfaces of the femora, much shorter and more appressed on the remainder of the legs. Anterior clypeal border with a row of golden yellow bristles. Pubescence on the head, thorax and scapes white, sparse and conspicuous, especially on the head; on the dorsal surface of the gaster brilliant golden yellow, and so long and dense as to cover the surface completely.

Whole body black, except the strigils of the fore tibiæ, which are deep red.

Worker minor.—Length 5–6.5 mm.

Differing from the major worker only in the smaller size and proportionally smaller and narrower head.

Described from numerous workers taken from a single colony, which was nesting in the crevice of a large rock at San Miguel. This species differs from *chilensis* in having the pronotum marginate on the sides, broader and more flattened above, the clypeus indistinctly instead of strongly carinate and in the pilosity, which is much more abundant, coarser and snow white. The golden pubescence on the gaster is also much more brilliant. That *pellarius* may eventually

turn out to be only a subspecies of *chilensis* seems to be indicated by a series of specimens in my collection taken by the Yale Expedition at Urubamba, Peru (9,500 ft.). These are intermediate between typical specimens of *chilensis* from Valparaiso in the breadth of the pronotum, and are much more pilose, with the pubescence on the gaster of a brilliant orange brown color.

[Reprinted from the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 7, No. 2, 1914]

CAN INSECTS BECOME RESISTANT TO SPRAYS?[1]

By A. L. MELANDER, *Entomologist, Washington Agricultural Experiment Station*

There is a prevalent feeling in some districts that sulphur-lime is less efficient now than formerly in controlling San José scale, or orchard aphides, or the brown mite. This has been largely ascribed to the general adoption of the factory-made clear solution which is popularly regarded as subject to a mysterious adulteration.

There seems to be no question but that some years and in some places sulphur-lime is a rapidly acting insecticide. In Piper's elaborate experiment at Wawawai, Washington, in 1902, he repeatedly found all the scales dead a week after the application. The same is true of some Wenatchee scales I examined two years ago. At the same time that these Wenatchee scales were counted, specimens from Clarkston, Washington, sprayed two weeks before, showed 90 per

[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 75.

cent alive. Even with 26° sulphur-lime, ten times stronger than a normal application, 74 per cent of the scales were still alive.

In the experiment of 1902 Piper discovered that sulphur-lime was equally effective whether applied one pound of sulphur to three gallons, or one pound to six gallons. I noted the same in some tests at Clarkston in 1908, but discovered that here and there on certain branches were individuals that were still alive a month after spraying, although as well covered by the spray as the others. This experiment was repeated in 1910 at Walla Walla, Washington, with the same results, except that a considerable number of the scales, averaging more than 10 per cent, was still alive.

For several years the San José scale has been increasingly prevalent in the Clarkston Valley. The growers have erected a local sulphur-lime factory in the effort to control faulty preparation of the spray; they have drenched their trees by power spraying in the endeavor to overcome faulty application, and yet the scale has uncontrollably spread. Some branches I examined in 1912, that had been given three applications, at intervals of about two weeks, using a hot sulphur-lime of the 30:40:100 formula, showed 50 per cent. of the scales still alive under the crust of dried spray.

This led us last spring at the Washington Station to try identical solutions in a number of localities, and then to make bi-weekly counts of the proportion of living and dead scales,—an experiment we were able to carry on through the help of the Adams Fund. Clarkston, Walla Walla, Kennewick, Prosser, Sunnyside, North Yakima and Wenatchee were the localities selected, comprising an air-line circuit of four hundred miles, and at each place materials from the same stock were used. In the course of the bi-weekly visits made to these places upwards of 350,000 scales were individually examined under the binocular microscopes, by my assistant, M. A. Yothers and myself.

PERCENTAGE OF LIVING SCALES

	No. Yakima				Sunnyside				Clarkston			
	When sprayed	2 weeks	4 weeks	6 weeks	When sprayed	2 weeks	4 weeks	6 weeks	When sprayed	2 weeks	4 weeks	6 weeks
1. Sulphur-lime 5°	92	57	30	0	95	60	6	0	95	90	77	8
2. Sulphur-lime 3°	92	80	51	0	95	78	3	0.5	95	92	81	13
3. Sulphur-lime 2°	92	75	40	0.5	95	76	4	0	95	90	76	17
4. Sulphur-lime, 1:½:5	92	88	35	0.1	95	93	2	0.2	95	93	75	4
5. Sulphur-lime, 1:2:5	92	50	22	0.2	95	58	4	0	95	77	52	8
6. Spramulsion	92	44	2	2	95	50	7	2.4	95	70	40	12
7. Orchard Brand Oil Spray	92	6	0	0	95	13	0	0	95	4	1	0
8. Fuel oil emulsion	92	60	0	0	95	91	0	0	95	62	0	0

For the sake of brevity the accompanying table shows the results obtained at but three of the places, North Yakima, Sunnyside and True's orchard, Clarkston, selected because the conditions for the experiment were ideal in each of these cases. The trees were vigorous, the scales abundant, the applications thorough and bad weather did not interfere. The figures show the proportion of scales rated as alive at the successive bi-weekly counts. The first experiment represents 5° factory-made sulphur-lime, approximating one pound of sulphur to three gallons. The second, 3° sulphur-lime, or one pound to five gallons, the third 2°, or one pound to seven gallons. Then follow two sulphur-limes prepared just before the application, experiment four, 3°, corresponding to the second experiment, and number five, with the same amount of sulphur but with four times the chemical requirement of lime. The sixth test gives a carbolated emulsion, called Spramulsion, prepared on the Pacific Coast. The last two represent oil sprays made with a fish oil emulsifier: Thomsen's Orchard Brand and a fuel oil emulsified during the tests.

It will be observed that the normal action of the sulphur-lime is continuous, producing complete destruction of the scale in a little more than a month's time. In the Clarkston experiment, however, from 4 to 13 per cent, or more, of the scales were alive six weeks after spraying, at which time they had begun their spring growth and were probably but little susceptible to whatever weathered sulphur-lime remained.

Attention may be called to the similarity of the results obtained with the last two oil sprays at all three places, showing that Clarkston scales have no resistance to these sprays, and to the similarity of the action of sulphur-lime used at North Yakima and Sunnyside, as compared with Clarkston. It is evident from these figures that the San José scale at Clarkston manifests a decided resistance to the action of sulphur-lime.

Although sulphur-lime has come to be regarded quite as a panacea, because of its destructive action on fungi, lichens, insect eggs, scales, etc., yet it is specifically a scalecide, and particularly is used against the San José scale during its hibernating condition. Other scales are less susceptible, the naked Lecaniums not at all, and thick shelled or active insects emerge quite unharmed from a bath of sulphur-lime. Even the San José scale shows a variable susceptibility, for during the growing period sulphur-lime has proved to be much less effective. Furthermore, there is a sex-difference, for among the resistant individuals escaping the action of the spray, the majority are males. Sulphur-lime is not a universal poison; it does not assure certain destruction of all insects; and there is thus a chance for an immunity

to manifest itself in increasing degree as the insects become acclimatized.

The physiological effect of sulphur-lime is believed to be due to a chemical reduction of the insect, an action that is vigorous at first but after a few weeks or days gives place to a chemical deposit of sulphur. The effects are thus not altogether immediate, but prolonged, and the reactions grow weaker day by day. That the San José scale is able to resist the first shock of deoxygenation is evident from the abundance of living scales for several weeks after the application.

It is a difficult matter to determine just when a scale insect dies. A killed scale becomes dry in a few days, during which time its protoplasm changes from a pale yellow juicy condition, through a viscous sirupy stage, to a darker yellow oily meal. This reaction is not reversible, and thus differs from the first effects of dessication, from which insects may be revived. In making counts of the scales we rated as dead all insects that showed gelation of the protoplasm when crushed under the microscope.

That the San José scale should become acclimatized to a sulphur-lime environment is not altogether a strange thing. There are organisms living in sulphur springs, in thermal springs, in hypertonic salt and alkaline lakes, and even in petroleum wells,—all of them environments fatal to normal forms. An example of such abnormal species in the making can be readily observed in an estuarial tension life-zone, where the salt water forms are invading the fresh water region, and the fresh water species are becoming adapted to the recurring tides.

One of the strangest instances of acclimation is the case of arsenic eaters. By consuming repeated small amounts of arsenic the body becomes immune to many times the normal lethal dose. When arsenic spraying for leaf-eating insects is imperfectly done it is quite possible for the insects to get daily homeopathic doses of arsenic and to become progressively resistant. Indeed, Mr. R. W. Glaser of the Bussey Institution, has experimentally verified this supposition in his work with the gipsy moth. By successively administering more and more spray, he tells me that he has succeeded in rearing a series of moths from larvæ that finally were feeding on heavy dosages of arsenate of lead. Indeed, these larvæ were especially hardy, and developed as strong an immunity to disease as they did to the arsenic. This may be the underlying reason why spraying for half-grown caterpillars and grasshoppers is usually so ineffective.

While immunity to arsenic may be a greater factor in the control of insects than we at present know, yet it is an adaptation of the

individual only. We do not know that such an acquired immunity affects subsequent generations, although it would not be inconceivable that arsenic antibodies are passed on by the mother into the egg to give the offspring some initial immunity.

The resistance of the San José scale, however, is of a different kind. Spraying affects every tenth generation or so, and it is quite unlikely that an acquired immunity should make its effects felt over so long a period. Sulphur-lime spraying in the orchard districts is compulsory by law and so practically every scale is subjected to its action. We have often noted an individual scale, or a group of scales, probably brothers and sisters, still alive in the midst of a mass of dead insects. Such vigorous individuals have been just as thoroughly wet with the sulphur-lime as their neighbors, yet have escaped its action. The sporadic occurrence of naturally immune individual scales finds a parallel in recent work on heredity of protozoa and bacteria. Mutants less or not susceptible to certain toxins have been repeatedly found in cultures and from them have been produced immune strains. Similarly, disease-resistant wheat has been produced through Mendelian segregation, the new strain acting as a pure recessive.

The data at present at hand do not permit us to determine whether resistance and susceptibility are differences of degree and not of kind, or whether they behave as allelomorphs. That the mortality curve of the Clarkston scales is less steeply inclined from the beginning might indicate a partial immunity already possessed by nearly all the scales, but which is pronounced enough to be an absolute immunity only in a relative few. Such a view is especially interesting when we recall the reported rapid action of sulphur-lime a few years ago.

What is the economic importance of the appearance in a locality of a resistant strain of the San José scale? An alarmist might say that a few such scales would soon result in a totally immune insect, brought about by annual spraying. But viewed from a Mendelian standpoint, the consequences are less direful. If only the resistant individuals survived to reproduce then a pure line might result after repeated sprayings. But always there are some scales missed by the spraying, and these, during the ten generations between sprayings, will produce a population in part, at least, non-resistant. If resistance were a dominant characteristic there would already be a larger proportion of immune individuals than the data show. If it is recessive the crossing with scales missed by the spray would, by the end of each year, produce a majority of susceptible individuals. Thus we may make the strange assertion that the more faulty the spraying this year the easier it will be to control the scale the next year.

Practically, a change from sulphur-lime to an oil spray is all that

is necessary for effectual control. However, even in the case of the oils we have noted a very few individuals that have manifested a remarkable tenacity of life. Should these result in a resistant strain sometime in the future it would be necessary to use both insecticides, and then if the same individuals were doubly resistant we might have to introduce a weak strain of the the San José scale to cross with the immunes and thus return to the normal susceptible population.

[Reprinted from BIOLOGICAL BULLETIN, Vol. XXVI., No. 3, March, 1914.]

OBSERVATIONS ON BLOW FLIES; DURATION OF THE PREPUPAL STAGE AND COLOR DETERMINATION.

PHINEAS W. WHITING.[1]

The results of two main lines of experiment upon blow flies are recorded in the following paper. The first was concerned with the duration of the prepupal or migration stage of the larvæ and the conclusions may be summarized as follows:

The length of the prepupal period is determined by environmental rather than by hereditary factors and these factors are both complex and obscure. In general, dryness, cold, or agitation due to crowding, tend to prevent pupation, while change from dryness to dampness or the reverse, induces pupation. The prepupal stage may be extended for a long period, four months in one experiment (1912-*f*), in warm temperature without injury to the development of adult flies, which emerge from the pupæ in normal condition. Lack of opportunity for the larvæ to bury themselves does not inhibit pupation. Exhaustion of the food supply before the larvæ have attained full size has a tendency to produce undersized but normally formed flies. The causes producing misshapen and imperfectly expanded flies are more obscure, but may be in part due to drying of the pupæ. Delayed pupation in *Lucilia* larvæ is evidenced by a change from white to pink in the fat bodies, but in two genera of larger flies, *Cynomyia* and *Calliphora*, the white color is maintained although considerable shrinkage of the whole body occurs. There is no evidence that overfeeding delays pupation, but much evidence that larvæ will pupate immediately despite the fact that they have had abundant opportunity to overeat.[2]

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University. No. 76.

[2] From his studies on blow flies, Herms (Herms, Wm. B., '07, "An Ecological and Experimental Study of Sarcophagidæ with Relation to Lake Beach Debris," *Jour. Exp. Zool.*, IV., 1) reaches the conclusion that an optimum of development is attained by the larvæ after a certain period of feeding and that continued feeding after this has a tendency to delay pupation. In many of my cultures, however,

The second main line of investigation was concerned with coloration in the adult flies and showed results as follows:

The first color assumed by the adults after their integument has hardened is a deep purple which rapidly changes to dark metallic blue in the larger forms experimented upon, *Cynomyia* and *Calliphora*, becoming greenish after a short time in the males of *Cynomyia*. In *Lucilia* the purple passes rapidly into a bright green, which is later replaced by more or less bronze. The degree of this bronzing tendency is evidently of an hereditary nature as different strains vary in this respect and selection is here effective. The environmental factors, light and temperature, seem to have no effect upon the degree or rapidity of this process.

The experiments recorded in this paper were performed upon the various species of blow-flies common in New England, especial attention being given to the common green-bottle fly, *Lucilia sericata*.[1]

larvæ of *Lucilia sericata* and *Cynomyia cadaverina*, which have been allowed to feed on all the fish that they would eat, on attaining the migration stage, have pupated within two or three days and have emerged from the pupæ in due course despite the fact that they have had plenty of opportunity to overeat.

In Table IV., Series 1, Herms records the mean weight of larvæ of *Lucilia* at the end of a feeding period of 60–72 hours as 38.183 milligrams, from 256 counts. This weight is regarded as the optimum for development. Among this series were a number that delayed pupation. These comprise Series 7. When weighed (there were 64 individuals) the mean weight was 33.59 milligrams. Although this weight is lower than the mean of Series 1, *it is considered*, that at the time of migration it must have been higher and that the difference is due to loss of moisture during the extended migration period, which had up to the time of weighing been twelve days. At the end of twenty days in the larval period as against a normal of about six days, 39 of these larvæ pupated, the rest being dead. *It is assumed* "that these larvæ were beyond the optimum weight, and for this reason pupation was deferred."

[1] Experiments were performed upon *Lucilia sericata* Meig., *L. sylvarum* Meig., *L. cæsar* L., *Calliphora erythrocephala* Meig., *C. viridescens* Desv., *C. vomitoria* L., and *Cynomyia cadaverina* Desv. Nothing has been done with the Sarcophagidæ, ... str., the flies named being included in the Calliphorinæ of the Muscidæ. Herms groups them all under the Sarcophagidæ, stating that he follows Girschner in this matter; but Girschner includes Calliphorinæ as his second group and Sarcophaga, Dexia, etc., as his fourth group under the family Tachinidæ, dropping the name Sarcophagidæ. (Girschner, E., '93, "Beitrag zur Systematik der Musciden," *Berl. Ent. Zeits.*, XXXVIII., 3).

While the work of Herms is said to have been done on *L. cæsar*, this is probably not correct as this species is relatively infrequent as compared with *L. sericata*, and Herms's material was collected from fish put out where all flies had ready

I have frequently found in my cultures imperfectly formed pupæ, sometimes misshapen and sometimes of normal form but with a soft covering. These have given rise in a few cases to undersized but normally formed flies, which lived as long as the full-sized individuals. In the majority of instances, however, the flies emerging were of normal size insofar as the chitinous parts of the body were concerned, but the abdomens appeared shrunken, the wings expanded only imperfectly, and the pigmentation failed to take on its customary brilliancy, remaining dull and opaque. This type of fly has also frequently appeared from pupæ apparently normal. In the case of *Luciliæ* which vary from a brilliant metallic green or greenish blue to a bright copper color becoming duller with age, the imperfectly formed flies resembled senescent individuals, being a dull coppery red. In the other larger species which are normally dark metallic blue with pollen that varies in amount in the different species and in the different individuals of the same species, the imperfectly expanded flies were dark blue in color without polish. That these imperfectly formed flies were hindered from normal development by drying of the pupæ, while small flies are produced from underfed larvæ might seem a reasonable explanation were it not

access, no distinction being made between the species of *Lucilia*. The relative abundance of *L. sericata* in the vicinity of Boston is especially to be observed where flies are crowded about a food supply in large numbers in which case it is only rarely that *L. cæsar* is taken. I have collected thousands of flies in the vicinity of the garbage scow, Boston, and at meat near the Bussey Institution, Forest Hills, and have found that less than one per cent. have been *L. cæsar*, while *L. sylvarum* has never been taken in such situations. At a very short distance from the Bussey Institution, however, where flies are relatively much fewer, *L. cæsar* and *L. sylvarum* have equalled and even surpassed *L. sericata* in numbers. I have never taken them, however, in any abundance. It is possible that *L. cæsar* may be more abundant in the region of the Great Lakes where Herms's work was done.

Calliphora erythrocephala is common about Boston all through the summer months while *viridescens* and *vomitoria* are rarely seen except in the spring and fall. *Cynomyia cadaverina* occurs only in the spring and fall and seems entirely to disappear during the summer. That these variations in frequency are entirely due to temperature and that there is no necessary periodicity in the breeding habits of the flies is evidenced by the facts that the forms disappearing during the summer still continue to breed farther north and that any of the species may be bred throughout the year by the proper regulation of temperature conditions. *Luciliæ* and *Calliphoræ* have been bred throughout the winter at Cambridge by Dr. A. O. Gross and *Calliphoræ* and *Cynomyia* have been bred during the entire year at Forest Hills by myself.

for the fact that in many cases the full-sized imperfectly formed specimens have come from pupæ kept damp. Nor can this be due in all cases to drying of the larvæ in the prepupal stage as will appear from experiment 1912-*f* recorded below.

Rarely has there been any considerable prolongation of the pupal stage in my experiments. Eclosion has taken place in approximately the time expected varying slightly with the species and the temperature. In one case, however, a few pupæ of *L. sericata* were obtained which failed to emerge and were kept for a number of weeks in a warm room in damp sand. At the end of that period they were examined for the possible presence of parasites, but nothing of that nature was found. I have no explanation to offer for this unusual fact.

On August 8, 1912, a female specimen of *L. sericata*, 1912-*f*, was taken at the garbage scow, Boston. She laid a number of eggs in less than a week and the larvæ soon reached the migration stage. This occurred before August 20. They were then placed in dry sawdust at room temperature and shortly there appeared thirteen flies, four males and nine females. None of the other larvæ pupated and at various times they were removed and examined. They seemed to be in a normal condition and reacted negatively to light. It was observed that the general tint of the larvæ gradually changed from white to light pink due possibly to the exhaustion of nutriment in the fat bodies. On October 23 they were all very pink but were still active although they had been in dry sawdust at room temperature for at least two months. At this time they were placed in damp sand and pupæ were soon formed from which thirteen males and eleven females emerged from November 11 to November 19. On November 20 and 21, several more flies emerged but unfortunately these were not counted. By December 4 the sand had dried somewhat and an examination showed nine larvæ remaining. The sand was dampened and on December 24, two flies emerged; on December 31, two more; and on January 3, one fly came out. This was the last of the lot, the other four having been killed on December 25 and studied for the presence of parasites, such as bacteria, etc. Nothing of this sort was found, however.

We have here then four larvæ which survived in the prepupal stage for at least four months at room temperature. The experiment indicates that in this case dryness has been the cause of the delay.

From the pupæ formed by these larvæ, there emerged after the usual time, flies which were of full size and completely expanded. The only difference observed in them from flies having a short prepupal period was the fact that the abdomen was contracted in a dorso-ventral direction. This deficiency, however, was corrected after a few days of feeding and the flies lived for a normal period of time. An extended prepupal stage under warm and dry conditions does not then necessarily produce misshapen flies, which often appeared from pupæ formed directly after the feeding period of the larvæ and which were permanently deformed, having the abdomen distorted and shrunken laterally as well.

From this experiment I conclude that hibernation may be undergone in the prepupal period. It is my opinion also that the majority of hibernating flies pass the winter in this condition and that the moistening of the soil in the spring by the melting of snow and the rain induces them to pupate. Many of the flies appearing on warm days in winter probably come from pupæ which are apparently not hindered from eclosion except by extreme cold.

That drying is not the only cause for delayed pupation, I am led to believe from the fact that in many instances larvæ have refused to pupate when buried in sand of all degrees of moisture in my various cultures both of *L. sericata* and of *C. cadaverina*. While this prolongation of the larval stage was in some cases undoubtedly due to cold, this cause could not be assigned to all cases as they often refused to pupate in summer temperature in moist sand.

A female of *L. sericata*, 1912-*V*, was taken at the Bussey Institution on November 20, 1912. One lot of her larvæ comprising 151 individuals reached the migration stage on December 4 and 5. They were distributed in eleven glass jars, but since conditions were the same in some of the jars I have grouped them for convenience into five series which represent the five conditions

offered. They were kept at room temperature in semidarkness during the day and complete darkness at night. Without exception the flies emerged from the pupa cases in due time. Table I. gives the record of this experiment.

TABLE I.

RECORD OF FIRST LOT OF PROGENY FROM *L. sericata* 1912–*V*.

Series No.	Material Placed in Jar.	No. of Larvæ Placed in Jar Dec. 5, 1912.	No. of Pupæ Formed.				
			Dec. 8.	Dec. 12.	Dec. 16.	Dec. 24.	Jan. 3.
1	Dry sand.	45	22	4	5	12	1 (1 larva dead)
2	Damp sand	45	38 (2 larvæ escaped)	3	1	1	
3	Damp loam	30	13 (loam some what dry)	1 (loam dry)	0 (loam dampened)	2	9 (5 larvæ left)
4	Damp sawdust	15	12	(3 larvæ escaped).			
5	Damp cloth	16	4	10 (1 larva dead)	1		

In the first place it is obvious from this table that drying has acted as an inhibitor to pupation while moisture has accelerated it. Thus in Series 1 we notice considerable delay in pupation produced apparently by the dryness of the environment. In Series 2 on the other hand, the damp sand furnished a very favorable condition for pupation. In Series 3 are a few pupations at first, and then with the drying out of the loam, pupation ceases. Moistening the medium again produces pupation. The very favorable conditions in Series 4 and 5 may be due to the fact that the sawdust and cloth were kept very moist. Series 5 shows also that it is not necessary that the larvæ should have a chance to bury themselves in order to pupate, and this I have observed in large numbers of cases in my cultures where the larvæ have readily pupated in wooden boxes as soon as they have left the fish. There is one other thing noticeable here which was not observed in the first experiment and that is that the larvæ in the dry sand although slightly slower in pupating than the others have not entered a condition of indefinite prolongation

of the prepupal period as in the case of 1912-*f*. My only explanation for this is that the temperature being higher in August than in November, drying out had been more rapid at the former time and thus a condition was reached in which the larvæ had not enough moisture to be able to pupate. This was supplied them in the later steps of the experiment.

The following experiment brings out another disturbing factor which acts as an inhibitor to pupation.

One hundred and seventy-six full-grown larvæ were obtained on December 11, 1912, which were also progeny from the later layings of the same *L. sericata* ♀, 1912-*V*. These were put into very damp sand crowded in a glass jar and kept at room temperature. On December 27 it was found that only 36 had pupated. The remaining 140 were distributed in five jars and their subsequent history is recorded in Table II.

TABLE II.

RECORD OF SECOND LOT OF PROGENY FROM *L. sericata*, 1912–*V*.

Series No.	Material Placed in Jar.	No. of Larvæ Placed in Jar Dec. 27, 1912.	No. of Pupæ Formed.				
			Jan. 3.	Jan. 19.	Feb. 5.	Feb. 15.	Mar. 14.
6	Dry sand	30	29	1			
7	Damp sand	30	7	0 (sand dry but dampened again slightly)	6 (sand dry and left so)	2 (19 larvæ including those from series 8 transferred to damp cloth)	19 dead flies found in bottle
8	Very damp sand	30	20	4	2 (sand dry, remaining larvæ put with Series 7)		
9	Dry bottle	30	30				
10	Damp cloth	20	7 (cloth dry and left so).	8	5		

From the delay in pupation from December 11 to December 27 it would appear that the crowding tended to inhibit pupation.

The larvæ were packed in so closely that their movements could be felt by each other and for this reason they were kept active. Upon being separated into smaller lots they soon pupated with the exception of Series 7. For the delay in this case I have no explanation, and it would appear that there are other unknown disturbing factors.

A female specimen of *Calliphora viridescens* (1912-21) was taken in the vicinity of the Bussey Institution, November 20, 1912. Eggs were soon deposited and the larvæ attained full growth on or before December 11. On that date they were placed in dry sand. No pupæ were formed and the larvæ were transferred to damp sand on December 18. Another transfer was made after about one week as pupation had not appeared and the larvæ were placed in dry sand. On January 7 a count was made and there were found to be 3 pupæ, 271 living larvæ, undersized and wrinkled, and 13 dead larvæ, wrinkled and dry. Of the three pupæ, 2 failed to emerge, although flies were formed inside, and the other emerged normally. The larvæ were placed in a jar with very damp cloth. Examination was not again made until January 30 when 2 normal flies were found, 1 ♂ and 1 ♀, 20 dead larvæ, 91 pupæ, and 158 living larvæ. The cloth was still damp. The larvæ were then transferred to a dry glass jar, and by February 15 were all dead and dried up, except that nine misshapen pupæ were formed which did not emerge. Of the other 91 pupæ which were kept on damp cloth only twelve had emerged by February 15, giving six males and six females. The others were dead.

The ill luck in getting these larvæ to pupate may be explained, I think, by the fact that they were at first crowded and thus disturbed each other. This was the condition up to January 7, a period of at least twenty-seven days, when they were observed to be undersized and wrinkled and some of them had died. Apparently in this case we have a condition very different from that of the first experiment recorded in this paper. It is possible that this may be due to the generic difference of the flies as prolongation of the larval stage of *Luciliæ* has often been observed to produce the pinkish coloration of the fat bodies, while in all cases the larger species, *Calliphoræ* and *Cynomyia*, have retained

their white color but have become more contracted. In general the larger species pupate more readily than the *Luciliæ*.

In no case has there been any correlation of abnormalities of chætotaxy either with imperfectly formed flies, or with perfectly formed undersized individuals. My counts include several thousand specimens of various sizes and the lack of any correlation between number of bristles and size has been so obvious that I have made no measurements to establish this principle. I can, however, furnish numerous specimens of full size with greatly reduced chætotaxy and numerous minute specimens having the full number of bristles and even additional ones. Walton,[1] however, from a count of ten specimens of *Belvosia bifasciata* Fabr. concludes that the larger specimens have additional bristles while the smaller individuals are likely to show reduction. As I have not made a study of the parasitic Tachinid flies, with respect to chætotaxy I am unable to pronounce upon the correctness of this conclusion. Number of bristles appears to be an hereditary matter in the blow-flies, Calliphorinæ,[2] and as yet there is no sufficient evidence that environmental factors enter into their determination.

The normal color changes of the fly after eclosion are of interest and may well be described here for comparison with the abnormal conditions. In all the species bred, the fly emerges from the puparium by pushing off the cap by means of the ptilinum. The insect is at first very small and shrunken, but in a few minutes the ptilinum is withdrawn and the tracheæ filled with air. Thus the fly immediately assumes a size much larger than the puparium from which it has just emerged. The color is now white with pinkish and bluish tints, which deepen in a few minutes until at the end of one half hour after eclosion they become deep purple. During the next hour this changes to the normal metallic blue in *Calliphoræ* and *Cynomyia*, the males of the latter genus gradually taking on more or less of a dark greenish color in the course of a few hours. In *Luciliæ* the condition is very different inasmuch

[1] Walton, W. R., '13, "The Variation of Structural Characters Used in the Classification of Some Muscoidean Flies," *Proc. Ent. Soc. Wash.*, XV., 1, Apr., 1913.

[2] Whiting, P. W., '13, "Observations on the Chætotaxy of Calliphorinæ," *Ann. Ent. Soc. of America*, VI., 2.

as the deep purple gives place to bright metallic green which is the color most in evidence at the end of one and one half hours after eclosion. If the fly be anæsthetized with ether the change of pigment is inhibited and the deep purple color may be made to persist throughout life. This does not seem in any way to interfere with the normal activities of the insect.

The assumption of the bronze color in *Lucilia sericata* was made the subject of some investigation and it was found that the factors governing the rapidity of production of this hue were to a great extent of an hereditary nature. Considerable variation occurs among the individuals in regard to the rapidity with which this change from green to bronze occurs and in general it may be said that this takes place in the males more rapidly than in the females. In both sexes, however, the bronze may appear in certain regions of the body before the purple has been replaced by green in other parts and it would appear as if in some cases the bronze followed the purple directly without the intervention of the green. Variation is also considerable as regards the position of the bronzing, in some cases the abdomen becoming bronze while the thorax is yet green, while in other cases the reverse occurs. No evidence is yet found for an environmental cause influencing the rapidity of bronzing, but the process appears to be altogether independent of light and temperature. As regards the latter factor, however, it is desirable that more thorough experiment should be performed under more perfectly controlled conditions. That the chief cause for bronzing, however, is hereditary appears from the following experiment.

A female of *L. sericata*, 1913-*E*, taken near the Bussey Institution, March 19, 1913, produced 39 males and 43 females. Of this lot those that reddened most quickly were selected and a mating was obtained from one pair. This pair produced 70 males and 77 females. A further selection was made from the reddest of these flies, which were examined in less than twenty-four hours after eclosion. One of the pairs selected produced a large family consisting of 366 males and 343 females. At this point the color selection was abandoned, the family being continued as a selection for additional bristles. A rapid effect of selection was noticed through the course of the experiment so that each

succeeding generation averaged much more bronzy in appearance than the preceding. At the close of the experiment in the F_3 generation, properly the second generation of selection, practically all the flies assumed considerable of the bronzy color before they were examined, which was done once every day.

In the selection in the opposite direction the results were not as striking. A female of *L. sericata*, 1913-*F*, was taken near the Bussey Institution, March 19, 1913. She was chosen because she appeared greener than many of the others that were seen about the building. In a few days she deposited eggs from which 24 males and 19 females were reared. Many of these were bronze-colored as soon as they had hardened but a few were green after a period of two or three days with but a slight amount of bronze. A single mating obtained from a pair of these latter gave 93 males and 90 females which averaged much greener than the second generation of the red selection 1912-*E*. At this point the experiment was cut short by the death of the flies selected.

The flies of both the red and the green selections were placed in boxes and allowed to become dry. It was intended to group them into classes according to color and thus to demonstrate more clearly the hereditary nature of the bronzing factors. After the specimens had dried, however, it was observed that the pigment had changed considerably, the reds becoming much greener and the greens often being streaked with blue. It was therefore found necessary to abandon this more accurate proof of the hereditary nature of the bronzing until such time as another selection could be made and the colors of the flies recorded as soon as killed by comparison with standard color charts.

Experiments are now under way which it is hoped will throw more light upon the conditions governing the life histories and habits of these flies.

My thanks are due to Mr. C. T. Brues for helpful criticism in the preparation of this paper and for many suggestions throughout the course of the work.

HEREDITY OF BRISTLES IN THE COMMON GREENBOTTLE FLY, LUCILIA SERICATA MEIG. A STUDY OF FACTORS GOVERNING DISTRIBUTION

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NEW YORK
1914

[Reprinted without change of paging, from the AMERICAN NATURALIST, 1914.

[Reprinted from The American Naturalist, Vol. XLVIII., June, 1914.]

HEREDITY OF BRISTLES IN THE COMMON GREENBOTTLE FLY, LUCILIA SERICATA MEIG. A STUDY OF FACTORS GOVERNING DISTRIBUTION[1]

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In a previous paper[2] I have given data showing that variation in the number of posterior dorso-central and acrostichal bristles of the common greenbottle fly, *Lucilia sericata* Meig., is determined by hereditary factors. Since the publication of that paper further evidence, bearing upon the nature of the hereditary factors involved, has been obtained.

Two general conclusions from the work may be stated as follows:

1. Reduction in bristles tends to affect the males more than the females, while additional bristles are found more often in the females.

2. Distribution as well as number of bristles is hereditary.

On account of very high mortality in these flies it has been impossible to make selections as might seem desirable. The results, however, furnish considerable evidence for the foregoing conclusions, and throw light, I believe, on the nature of factors governing distribution, such as spotting factors, for example.

Fig. 1 shows the mesonotum of *Lucilia sericata* with chætotaxy normal. The bristles considered in my work are those lettered *A, B, C,* the post-acrostichals, and *A′*, *B′*, *C′*, the post-dorso-centrals.

[1] From the Entomological Laboratory of the Bussey Institution, Harvard University, No. 77.

[2] Whiting, P. W., "Observations on the Chætotaxy of Calliphorinæ," *Annals of the Entomological Society of America,* VI, 2.

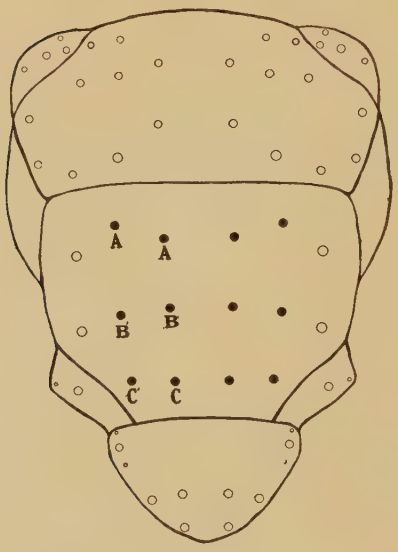


FIG. 1.

It is evident that these bristles form a group of twelve in four rows of three each.

This arrangement is recorded as 3, 3, 3, 3, the separation into rows being denoted by commas.

When one or two of the anterior bristles of a row are omitted, the row is denoted by 2 or 1, respectively.

In order to denote the omission of the second or third bristle when those anterior to it are not omitted, the normal positions of the bristles are recorded as a, b, c, from anterior to posterior. Thus a row lacking the second bristle would be called ac.

Addition of a supernumerary bristle into a row is denoted by ! inserted in the proper position between or in front of the letters denoting the normal bristles. Thus addition of a bristle in front of a row would be expressed by calling the row !abc.

Insertion of a supernumerary bristle between the normal rows is denoted by parentheses enclosing a, b, or c, acording to the position of the bristle from anterior to posterior. Thus a definition as 3, (a), 3, 3, 3, would denote the addition of a bristle between the first left post-dorso-central and the first left post-acrostichal.

Additional bristles are usually smaller than the normal, but range all the way from microchaetæ to the size of the normal macrochætæ. A small bristle is denoted by italics.

The progeny of a few wild females have been bred and counted since my previous paper.[3] These have been

TABLE I

RECORD OF FLIES BRED FROM FEMALES TAKEN WILD

First generations only included here, hence not inbred. In the counts relating to reduction total absence of a bristle is counted as 1.0. A small-sized bristle is counted as a decrease of 0.5.

Mothers	Progeny from Flies Recorded in First Column																
	Number of Flies Showing Bristles						Total Progeny	Bristles Lacking in "Decreased" Flies								Bristles Added in "Increased" Flies	
	Normal		Decreased.		Increased.			Acrostichals						Dorso-centrals			
								1st		2d		3d					
	♂	♀	♂	♀	♂	♀		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
12 normal flies	651	672	21	6	13	16	1,379	15	3	8	3	2	1	0	0	16	25
10 flies lacking 15 acrostichals (7 first, 6 second, and 2 third lacking)	258	289	30	7	3	3	590	16.5	5	15	3	1	0	1	0	4	3
4 flies having 7 bristles extra	154	125	2	5	10	8	304	0	1	1	4	0	1	0	0	11	9
Totals from 26 flies	1,063	1,086	53	18	26	27	2,273	31.5	9	24	10	3	2	1	0	31	37

Total males, 1,142. Number of bristles lacking in males 59.5.

Total females, 1,131. Number of bristles lacking in females, 22.

averaged with those recorded previously and the results given in Table I.

From this table it appears that progeny of normal mothers show a certain degree of variation in the direction both of loss and of acquisition of bristles; progeny of reduced mothers tend more toward reduction; and progeny of mothers bearing additional bristles tend more toward the addition of bristles. It is also evident that in

[3] It is thought desirable to put on record a detailed account of these families as they furnish in themselves a few points of interest. This record is given below with the exception of the progeny of 1913-*A*, discussed in a later part of this paper.

1913-*B*, *L. sericata* ♀ = 3, ab, ab, 3, taken at Bussey Institution, May 6, 1913, gave

11 ♂♂ = 3, 3, 3, 3.	
1 ♂ = 3, 3, 3, 2.	
3 ♂♂ = 3, 2, 3, 3.	17 ♀♀ = 3, 3, 3, 3.
1 ♂ = 3, 3, ac, 3.	1 ♀ = 3, 2, 3, 3.

1913-*C*, *L. sericata* ♀ = 3, 3, 2, 3, taken at Bussey Institution, May 6, 1913, gave

49 ♂♂ = 3, 3, 3, 3.	57 ♀♀ = 3, 3, 3, 3.
1 ♂ = 3, 3, *a*bc, 3.	1 ♀ = !abc, a!bc, 3, 3.
1 ♂ = 3, a!bc, a!bc, 3.	1 ♀ = 3, a!bc, 3, 3.
1 ♂ = 3, a!bc, 3, 3.	
1 ♂ = 3, !abc, 3, 3.	

In this case I attribute the additional bristles to the combination of factors introduced by the male. An example of this sort in which a reduced female produces offspring abnormal predominantly by addition is very unusual. There are, however, occasionally flies with extra bristles in reduced strains, a fact which may be explained by recombinations of factors or by mutation.

1913-*F*, *L. sericata* ♀ = 3, 3, 3, 3, taken at Bussey Institution, March 19, 1913, gave

24 ♂♂ = 3, 3, 3, 3.	19 ♀♀ = 3, 3, 3, 3.

from a mating of these were produced

92 ♂♂ = 3, 3, 3, 3.	89 ♀♀ = 3, 3, 3, 3.
1 ♂ = 3, 3, a!bc, 3.	1 ♀ = 3, a!bc, 3, 3.

1913-*D*, *L. cæsar* ♀ = 3, 2, 2, 3 (the chætotaxy normal for this species), taken at Bussey Institution, May 5, 1913 gave

55 ♂♂ = 3, 2, 2, 3.	34 ♀♀ = 3, 2, 2, 3
4 ♂♂ = 3, 1, 2, 3.	1 ♀ = ac, 2, 2, 3.
1 ♂ = 3, 2, b, 3.	
2 ♂♂ = 3, 1, 1, 3.	
1 ♂ = 3, 2, 1, 3.	
1 ♂ = 3, b, 2, 3.	

The flies of this mating are not averaged with the others, as it is possible that this species may be different in its variability from *L. sericata*. It is noteworthy, however, that here also reduction favors the male more than the female.

general reduction tends considerably to favor the males, while addition favors the females to a slight extent.

In my previous paper (p. 264) is given in detail a record of the progeny of a female *L. sericata* (1912-c) lacking both of the first and the right second post-acrostichal (3, 2, 1, 3). These were inbred to the third generation, in all cases brother being mated with sister in an attempt to analyze the stock as thoroughly as possible and to reduce heterozygosis of factors.[4] Here again, due

[4] Mr. Harold D. Fish has kindly furnished me the following note:

"The importance of mating sisters with brothers for a long series of generations in the experiments aimed to detect Mendelizing units of inheritance and analyze groups of them, quite generally seems to have been overlooked. As first shown by Castle ('03), random mating of the individuals of successive generations beyond F_1 tends to produce in each generation a population with the same per cent. of homozygosis and heterozygosis as is present in the F_2 generation, *i. e.*, 25 per cent. of the individuals are homozygous for one factor of a given allelomorphic pair, 25 per cent. homozygous for the other factor, and 50 per cent. heterozygous for both. Such a system of random matings often has been confused with the more restricted system of mating sisters with brothers.

"It is evident that if *A* and *B* are an allelomorphic pair the F_2 zygotes, resulting from a mating of *AA* with *BB*, will be *AA*, 2*AB* and *BB*. Further, if these are all females and are mated in all possible ways with the same number and kinds of males, one sixteenth of the matings will be *AA* with *AA*, and one sixteenth will be *BB* with *BB*. One eighth of the matings, then, will be homozygous and produce only homozygous young, which, because of the restricted system of mating only sisters with brothers, will produce, in turn, only homozygous matings. The remaining matings, seven eighths of the total, will produce various proportions of homozygous and heterozygous offspring and matings. It is rather natural to assume that one eighth of these matings will be homozygous and seven eighths heterozygous. This would mean that the proportion of heterozygous matings between individuals of the F_n generation would be $(7/8)^{n-1}$. Accordingly one would expect an automatic increase in homozygosis. The expectation is justified although the figures are misleading.

"Dr. Raymond Pearl first published the figures exactly expressing the per cent. of automatic increase in homozygosis for paired allelomorphs, under the restriction of mating only sisters with brothers. This article appeared in the January, 1914, number of the AMERICAN NATURALIST. It is a correction of his paper in the October, 1913, number of the same periodical, in which he states in no uncertain terms that an automatic increase in homozygosis in obligate bisexual forms is impossible. When I read the October paper I was naturally much surprised, since, nearly a year before, during conversation with Mr. Whiting, the increasing per cent. of homozygous matings resulting from successive matings of sisters with brothers had been discussed. Of course, the per cent. of individuals in any generation, which are homozygous for one or the other of a pair of allelomorphs, is the same

to high mortality, selection as might have been desired has been impossible.

A detailed account of this strain is given in Table II. In recording any mating of this strain the letter *c* denoting the entire strain, is followed by F_1, F_2, etc., denoting the generation from which the mated flies have been chosen. This symbol is then followed by *a, b,* or *c,* denoting the first, second, or third mating, respectively, of the generation indicated. Thus mating cF_2b is the second mating of the second inbred generation of strain 1912—*c*. This method of recording matings has been followed throughout my work.

Several points of interest are to be noted in this strain but it is thought best to present the remaining data on reduced strains before proceeding to a discussion of this matter.

Strict inbreeding has been followed in the strain recorded below. In no case have there been either cousin-matings or outcrossings.

1913-*A, L. sericata* ♀ = 3, ac, ac, 3, taken at Bussey Institution, Forest Hills, Mass., May 6, 1913, gave

F_1

96 ♂♂ = 3, 3, 3, 3.	129 ♀♀ = 3, 3, 3, 3.
1 ♂♂ = 3, ac, ac, 3.	1 ♀ = 3, ac, 3, 3.
2 ♂♂ = 3, ac, 3, 3.	2 ♀♀ = 3, 2, 3, 3.
2 ♂♂ = 3, 3, ac, 3.	
1 ♂ = 3, 2, ac, 3.	
4 ♂♂ = 3, 2, 3, 3.	
3 ♂♂ = 3, 3, 2, 3.	

as the per cent. of the allelomorphic factors which are homozygous in the average individual of that generation. Because Dr. Pearl in his October paper referred frequently to the paper by Dr. E. M. East ('12) on "Heterozygosis in Evolution and Plant Breeding." I gave Dr. East my figure expressing the per cent. of homozygosis in successive generations resulting from matings of sisters with brothers. Dr. Pearl's correction followed a letter from Dr. East which pointed out the error of applying the mathematics of random matings in each generation to a case where sisters always had been mated with brothers. The percentages, as computed, were published by Dr. Pearl for the following generations: P_1—100 per cent., F_1—0 per cent., F_2—50 per cent., F_3—50 per cent., F_4—62.5 per cent., F_5—68.25 per cent., F_6—75 per cent., F_7—79.687 per cent., F_8—83.594 per cent, F_9—86.719 per cent., F_{10}—89.258 per cent. Previous to giving these figures to Dr. East I computed the number of generations necessary to reduce heterozygosis to less than one half of one per cent. and found this condition first realized in the F_{25} generation, which is 99.553 per cent. homozygous. The importance of these figures in work of this nature is quite obvious."

TABLE II

RECORD OF STRAIN 1912*c*, *L. sericata* ♀ (3, 2, 1, 3), TAKEN AT THE GARBAGE SCOW, BOSTON, AUGUST 8, 1912

Generations and Character of Matings	Progeny from Matings Recorded in First Column																	
	Number of Flies Showing Bristles						Total Progeny	Bristles Lacking in "Decreased" Flies								Bristles Added in "Increased" Flies	
	Normal		Decreased		Increased			Acrostichals						Dorso-centrals			
								1st		2d		3d					
	♂	♀	♂	♀	♂	♀		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
F_1 from mother = (3, 2, 1, 3)	10	12	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0
F_2 from cF_1 *a* = normal pair	10	7	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0
F_2 from cF_1b = normal pair	42	39	2	2	2	0	87	1	0	0	3	0	0	2 (2d)	0	2	0
F_2 from cF_1c = normal pair	55	62	10	9	1	0	137	16	7	0	1	0	1	1 (2d)	1 (1st)	1	0
F_3 from cF_2a = normal male × 2 normal females	163	170	6	6	2	7	354	1	0	4	2	0	0	0	4 (1st) 3.5 (2d) 2 (3d)	2	8
F_3 from cF_2b = normal pair	92	85	0	1	11	4	193	0	0	0	1	0	0	0	0	13	4
Totals	372	375	18	18	16	11	810	18	7	4	7	0	1	3	10.5	18	12

F_2

from AF_1a = ♂ = 3, ac, 3, 3.
♀ = 3, 2, 3, 3.

24 ♂♂ = 3, 3, 3, 3.	53 ♀♀ = 3, 3, 3, 3.
11 ♂♂ = 3, ac, ac, 3.	2 ♀♀ = 3, ac, ac, 3.
13 ♂♂ = 3, ac, 3, 3.	5 ♀♀ = 3, 3, ac, 3.
9 ♂♂ = 3, 3, ac, 3.	1 ♀ = 3, ac, abc, 3.
2 ♂♂ = 3, abc, ac, 3.	1 ♀ = 3, ac, 2, 3.
1 ♂ = 3, 3, abc, 3.	2 ♀♀ = 3, 3, abc, 3.
1 ♂ = 3, 1, 1, 3.	1 ♀ = 3, abc, 3, 3.
3 ♂♂ = 3, ac, 2, 3.	1 ♀ = 3, abc, 2, 3.
5 ♂♂ = 3, 2, ac, 3.	2 ♀♀ = 3, 2, 2, 3.
1 ♂ = 3, 2, 2, 3.	1 ♀ = 3, 3, 2, 3.
5 ♂♂ = 3, 2, 3, 3.	1 ♀ = 3, 3, a!!c, 3, 3.
2 ♂♂ = 3, 3, 2, 3.	1 ♀ = 3, a!bc, 3, 3.
1 ♂ = 3, acc, 3, 3.	

F_3

from AF_2a = ♂ and ♀ = 3, ac, ac, 3. Pair segregated July 12; larvæ July 25.

♂♂	♀♀	♂♂	♀♀
6	35 = 3, 3, 3, 3.	7	2 = 3, 2, ac, 3.
42	18 = 3, ac, ac, 3.	10	4 = 3, 2, 2, 3.
9	18 = 3, ac, 3, 3.	7	7 = 3, 2, 3, 3.
16	12 = 3, 3, ac, 3.	5	7 = 3, 3, 2, 3.
5	2 = 3, ac, 2, 3.	1	0 = 3, ac, a, 3.

from AF_2b =
♂ = 3, ac, 2, 3.
♀ = 3, abc, 2, 3.
Pair segregated July 12; larvae July 25.

♂♂	♀♀	♂♂	♀♀
16	45 = 3, 3, 3, 3.	4	1 = 3, 3, 2, 3.
34	9 = 3, ac, ac, 3.	0	1 = 3, abc, ac, 3.
8	9 = 3, ac, 3, 3.	0	3 = 3, 3, abc, 3.
7	11 = 3, 3, ac, 3.	0	3 = 3, abc, abc, 3.
8	0 = 3, ac, 2, 3.	1	0 = 3, b, 3, 3.
9	1 = 3, 2, ac, 3.	1	0 = 3, ac, abc, 3.
3	0 = 3, 2, 2, 3.	0	1 = 3, abc, 3, 3.
2	1 = 3, 2, 3, 3.		

F_4

from AF_3a = ♂ = 3, ac, a, 3, from AF_2a. Pair segregated August 14; ♀ = 3, ac, ac, 3, larvæ August 20.

♂♂	♀♀	♂♂	♀♀
6	32 = 3, 3, 3, 3.	4	7 = 3, 2, 3, 3.
24	11 = 3, ac, ac, 3.	1	5 = 3, 3, 2, 3.
4	20 = 3, ac, 3, 3.	1	0 = 3, ac, 1, 3.
6	13 = 3, 3, ac, 3.	0	1 = 3, ac, 3, 3.
9	6 = 3, ac, 2, 3.	1	0 = 3, ac, bcc, 3.
6	7 = 3, 2, ac, 3.	0	1 = 2, 2, 2, 3.
3	4 = 3, 2, 2, 3.	0	1 = 3, 3, abbc, 3.

from AF_3b = ♂ and ♀ = 3, 2, ac, 3, from AF_2a. Pair segregated August 13; larvæ August 20.

♂♂	♀♀	♂♂	♀♀
0	18 = 3, 3, 3, 3.	13	2 = 3, 2, ac, 3.
10	3 = 3, ac, ac, 3.	6	2 = 3, 2, 2, 3.
4	5 = 3, ac, 3, 3.	1	7 = 3, 2, 3, 3.
1	2 = 3, 3, ac, 3.	1	4 = 3, 3, 2, 3.
13	3 = 3, ac, 2, 3.		

from AF_3c = ♂ and ♀ = 3, 2, 2, 3, from AF_2a. Pair segregated August 13; larvæ August 25.

♂♂	♀♀	♂♂	♀♀
6	15 = 3, 3, 3, 3.	2	15 = 3, 2, 3, 3.
10	7 = 3, ac, ac, 3.	3	8 = 3, 3, 2, 3.
11	7 = 3, ac, 3, 3.	0	1 = ac, 1, 2, ac.
10	12 = 3, 3, ac, 3.	1	0 = 3, 2, acc, 3.
8	3 = 3, ac, 2, 3.	2	1 = 3, acc, ac, 3.
7	7 = 3, 2, ac, 3.	1	0 = 3, acc, 3, 3.
5	4 = 3, 2, 2, 3.		

from AF_3d = ♂ and ♀ = 3, ac, ac, 3, from AF_2a. Pair segregated August 13; male died August 18 and another with same chætotaxy put in; larvæ September 1.

♂♂	♀♀	♂♂	♀♀
0	3 = 3, 3, 3, 3.	1	1 = 3, ac, 2, 3.
1	2 = 3, ac, 3, 3.	1	0 = 3, 3, aabc, 3.
1	1 = 3, 3, ac, 3.		

The record of 1913-*A*, recorded in tabular form is given in Table III.

We are now in a position to consider the nature of reduction of bristles in *Lucilia sericata*.

It is evident from Table I (record of first generation flies), that reduction and addition of bristles are both hereditary. It is further evident from Table III, (inbred strain), that reduction yields readily to selection. This effect may be expressed by making the number of bristles lost the numerator of a fraction of which the denominator is the number of bristles normal. We then have a ratio for each generation of 1913—*A* as follows:

$$F_1 \cdot \frac{18}{2892} = 0.006 \pm .010, \qquad F_3 \cdot \frac{435}{4692} = 0.093 \pm .003,$$

$$F_2 \cdot \frac{99}{1788} = 0.055 \pm .004, \qquad F_4 \cdot \frac{532.5}{5100} = 0.104 \pm .003.$$

It may be readily seen by glancing at these figures that selection has a very rapid effect. It also appears that as we pass from F_1 to F_4 the effect of selection gradually diminishes. This may be expressed by dividing the above decimals for each generation by that of the preceding generation.

$$\frac{F_2}{F_1} = \frac{0.055}{0.006} = 9.16, \qquad \frac{F_3}{F_2} = \frac{0.093}{0.055} = 1.69,$$

$$\frac{F_4}{F_3} = \frac{0.104}{0.093} = 1.11.$$

The reason for this decrease in the effect of selection in the later generations is that as the selection advances the majority of the flies become reduced in two bristles only.

TABLE III

RECORD OF STRAIN 1913-*A*, *L. sericata* ♀ (3, ac, ac, 3) TAKEN AT THE BUSSEY INSTITUTION, FOREST HILLS, MASS., MAY 6, 1913

Generations and Character of Matings	Progeny from Matings Recorded in First Column																			
	Number of Flies Showing Bristles						Decreased and Increased in Same Individual		Total Progeny	Bristles Lacking in "Decreased" Flies								Bristles Added in "Increased" Flies		Small 2d Acrostichals
	Normal		Decreased		Increased					Acrostichals						Dorso-centrals				
										1st		2d		3d						
	♂	♀	♂	♀	♂	♀	♂	♀		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
F_1 from mother = (3, ac, ac, 3)	96	129	13	3	0	0	0	0	241	8	2	7	1	0	0	0	0	0	0	0
F_2 from AF_1a = ♂ =3, ac, 3, 3, ♀ =3, 2, 3, 3	24	53	53	16	0	1	1	1	149	19	7	58.5	14.5	0	0	0	0	1	2	8
F_3 from AF_2a = ♂ and ♀ =3, ac, ac, 3	6	35	102	70	0	0	0	0	213	34	26	123	70	1	0	0	0	0	0	0
F_3 from AF_2b = ♂ =3, ac, 2, 3, ♀ =3, *abc*, 2, 3	16	45	77	40	0	0	0	0	178	30	3	101.5	45.5	1	0	0	0	0	0	12
F_4 from AF_3a = ♂ =3, ac, a, 3, ♀ =3, ac, ac, 3, from AF_2a	6	32	58	75	0	0	1	1	173	28	36	76	69.5	0	0	0	1 (1st)	1	0	2
F_4 from AF_3b = ♂ and ♀ =3, 2, ac, 3 from AF_2a	0	18	49	28	0	0	0	0	95	40	20	51	18	0	0	0	0	0	0	0
F_4 from AF_3c = ♂ and ♀ =3, 2, 2, 3, from AF_2a	6	15	56	64	0	0	4	1	146	31	43	62	46	0	0	0	2 (2d)	4	1	0
F_4 from AF_3d = ♂ and ♀ =3, ac, ac, 3, from AF_2a	0	3	3	4	1	0	0	0	11	1	1	3	4	0	0	0	0	1	0	0
Totals	154	330	411	300	1	1	6	3	1,206	191	138	482	268.5	2	0	0	3	7	3	

Rarely does a fly occur lacking more than two. In the few cases in which three or more bristles are lacking, the absence of the third acrostichals or of the dorso-centrals is as frequent as the absence of first and second acrostichals. Why this should be is difficult to understand, as it would be expected that both first and both second post-acrostichals might frequently be lacking in the same fly, especially as flies asymmetrical for the loss of these bristles are common.

A further point of interest lies in the fact that not only is *number* of bristles a hereditary matter, but their *distribution* is also hereditary. Thus from Table I (first-generation flies) we see that in general the first post-acrostichals tend to be reduced more than the second. This may be expressed as a fraction:

$$\frac{\text{First post-acrostichals lacking}}{\text{Second post-acrostichals lacking}} = \frac{40.5}{34} = 1.19.$$

It is possible that this tendency to reduce the first post-acrostichal more than the second is evidence of relationship to *L. cæsar* Linn., in which the absence of the former and the presence of the latter is the normal condition. Strain 1913—*A* (Table III), however, gives

$$\frac{\text{First post-acrostichals lacking}}{\text{Second post-acrostichals lacking}} = \frac{329}{750} = 0.43.$$

Considering the reduction in the first post-acrostichals separately, we may express the effect of selection as follows:

Parents. Matings.	1st post-acros. lacking.	Offspring. First post-acros. lacking. / First post-across. normal (2 per fly).
A	0(?)	$\frac{10}{482} = 0.021 \pm .004.$
AF_1a	1	$\frac{26}{298} = 0.087 \pm .011.$
AF_2a	0	$\frac{60}{426} = 0.141 \pm .002.$
AF_2b	2	$\frac{33}{356} = 0.093 \pm .010.$

AF_3a	0	$\frac{64}{346} = 0.185 \pm .014.$
AF_3b	2	$\frac{60}{190} = 0.316 \pm .023.$
AF_3c	4	$\frac{74}{292} = 0.253 \pm .017.$

From these figures it is readily seen that reduction in the first post-acrostichals is not entirely consistent with the direction of selection.

Let us test the same matter for reduction in the second post-acrostichals.

Parents Matings	1st post-acros. lacking	Offspring. First post-acros. lacking. / First post-acros. normal (2 per fly)
A	2(?)	$\frac{8}{482} = 0.017 \pm .004.$
AF_1a	1	$\frac{63}{298} = 0.211 \pm .016.$
AF_2a	4	$\frac{193}{426} = 0.453 \pm .016.$
AF_2b	1.5	$\frac{147}{356} = 0.413 \pm .018.$
AF_3a	4	$\frac{145.5}{346} = 0.420 \pm .179.$
AF_3b	2	$\frac{69}{190} = 0.363 \pm .023$
AF_3c	0	$\frac{108}{292} = 0.370 \pm .019.$

In this case also the results are not consistent with the direction of selection, although there is better agreement here than in the case of the first post-acrostichals. This is probably due to the fact that the numbers are larger. As regards the irregularities that do occur, I consider them as evidence of recombinations of multiple factors, insofar as they are not due to probable error.

1912—*c* (Table II) is a strain that especially tends to lack the first post-acrostichals. Thus for the entire strain

$$\frac{\text{First post-acrostichals lacking}}{\text{Second post-acrostichals lacking}} = \frac{25}{11} = 2.27.$$

In the 137 offspring of a single mating of this strain, $c\mathrm{F}_1c$, there are 23 first post-acrostichals lacking, showing that it is due to this mating especially that the strain is so lacking in first post-acrostichals.

It can not as yet be said that the factors governing the first post-acrostichals are altogether independent of those governing the second. That a certain degree of independence obtains is evident from a comparison of the ratio of reduction in first to reduction in second post-acrostichals in flies in general (Table I), with the same ratio for strain 1913—*A*. In the former case we have 40.5/34 or 1.19. In the latter we have 329/750, or 0.43. In order to establish the independence of the factors underlying these two tendencies it will be necessary to obtain, either by selection from a strain showing both tendencies or by breeding from wild stock, two strains, one tending to lack the first while retaining the second, and the other tending to lack the second while retaining the first.

A point of interest in strain 1913—*A* is the presence of twelve small second post-acrostichals in the progeny of $A\mathrm{F}_2b$ in which the female had one of these reduced to half size. The progeny of $A\mathrm{F}_2a$ in which there was total absence of these bristles showed either presence or absence of the same but no reduced bristles. In F_2, however, we have eight reduced bristles. The occurence of these small bristles in the progeny of certain matings is taken as an indication of recombinations of multiple factors, but the numbers are too small to establish this with certainty.

A glance at the tables shows that third post-acrostichals are rarely lacking. These are normally present in all related species, while in a few,—*Cynomyia mortuorum, Musca domestica, Pseudopyrellia cornicina,* and others, there is normally but one post-acrostichal, and this is always the last.

Posterior dorso-centrals are very rarely absent. Thus in the 2,273 flies recorded in Table I only one had a single post-dorso-central missing. Reduction in post-acrosti-

chals among these is 79.5. Among the 1,206 flies of strain 1913—*A* there are but three post-dorso-centrals gone. This latter is a highly reduced strain as regards post-acrostichals, lacking 1,081. This great reduction in acrostichals seems not appreciably to have affected the dorso-centrals, a fact which argues for the independence of the factors controlling the distribution of these two sets of bristles.

Thus for flies recorded in Table I we have

$$\frac{\text{Post-acrostichals lacking}}{\text{Number of Flies}} = \frac{79.5}{2273} = 0.03.$$

One post-dorso-central lacking.

For flies in strain 1913—*A* (Table III) we have

$$\frac{\text{Post-acrostichals lacking}}{\text{Number of Flies}} = \frac{1081}{1206} = 0.89.$$

Three post-dorso-centrals lacking.

Among the 3,238 flies recorded in Tables I and III only four post-dorso-centrals are lacking, while among the 810 flies of strain 1912—*c* (Table II) there are 13.5 lacking. The lack of post-acrostichals in this latter strain is 37. There are 9.5 dorso-centrals lacking in the progeny of the trio, cF_2a, among which there are only seven post-acrostichals lacking.

Thus we see that lack of post-dorso-centrals is in no way correlated with lack of post-acrostichals, but is evidently governed by distinct factors.

Variation by Addition of Bristles

A strain of *Lucilia sericata,* 1913—*E,* showed some interesting variations chiefly in the direction of addition of bristles. The mother was normal (3, 3, 3, 3), taken at the Bussey Institution, March 19, 1913. The detailed account of the strain follows:

F_1

♂♂	♀♀
38	43 = 3, 3, 3, 3.
1	0 = 3, 3, ab!c, 3.

F_2

from $EF_1a = \begin{cases} ♂ = 3, 3, \text{ab!c}, 3. \\ ♀ = 3, 3, 3, 3. \end{cases}$

♂♂	♀♀	
69	76	= 3, 3, 3, 3.
1	0	= ab!c, 3, 3, 3.
0	1	= !abc, 3, 3, !abc.

F_3
from EF_2a = ♂ and ♀ = 3, 3, 3, 3.

♂♂	♀♀		♂♂	♀♀	
318	251	= 3, 3, 3, 3.	4	5	= 3, a!bc, 3, 3.
13	51	= !abc, 3, 3, !abc.	0	1	= !a!bc, 3, 3, !abc.
1	4	= !abc, 3, 3, 3.	1	0	= 3, abc!, abc!, 3.
6	6	= 3, 3, 3, !abc.	1	0	= !abc, a!bc, a!bc, !a
1	3	= 3 (a), 3, 3, 3.	0	1	= !abc, a!bc, 3, !abc
5	2	= 3, 3, 3 (a), 3.	1	0	= 3, ab!c, 3, 3.
3	5	= 3, 3, a!bc, 3.	1	1	= a!bc, 3, 3, a!bc.
1	0	= 3, a!bc, abc!, 3.	0	3	= !abc, 3, 3, !a!bc.
1	0	= 3, 3, 3, a!bc.	0	1	= 3, a!bc, 3, !abc.
1	0	= 3, 3, 3, ab!c.	0	1	= !abc, 3, 3 (a), !abc
1	0	= !abc, a!bc, 3, 3.	0	1	= !abc, a!bc, 3, !a!bc
1	0	= 3, 3, 3 (b), 3.	0	1	= a!bc, 3, a!bc, a!bc.
1	1	= 3, a!bc, a!bc, 3.	1	0	= !bc, 3, 3, !a!bc.
1	0	= !a!bc, !a!bc, !a!bc, !a!bc.	1	0	= 3, 3, 2, 3.
0	1	= 3 (b), 3, a!bc, a!bc.	1	0	= 3, ac, 3, 3.
0	2	= !a!bc, 3, 3, !abc.	1	0	= 3, ac, ac, 3.
0	1	= !abc, 3, a!bc, !abc.	0	1	= 3, abc, 3, 3.

F_4
from EF_3a = ♂ = 3, 3, 3, 3.; ♀ = 3, 3, a!bc, 3.
Pair segregated, July 22; larvæ July 30.

♂♂	♀♀		♂♂	♀♀	
191	100	= 3, 3, 3, 3.	1	0	= !abc, 3, abc!, !abc.
25	43	= !abc, 3, 3, !abc.	2	0	= 3, abc!, 3, 3.
4	3	= !abc, 3, 3, 3.	1	0	= !abc (a), 3, 3.
0	1	= 3, 3, 3, !abc.	1	0	= 3 (a), 3, 3 (a), 3.
0	1	= !abc, a!bc, 3, !abc.	1	1	= !abc, 3, 3 (a), !abc.
1	2	= !abc, 3, a!bc, !abc.	0	1	= !bc, 3, 3, 3.
0	2	= !abc, a!bc, a!bc, !abc.			

from EF_3b = ♂ and ♀ = 3, 3, 3, 3. Pair segregated August 22.

♂♂	♀♀		♂♂	♀♀	
41	57	= 3, 3, 3, 3.	2	0	= 3, a!bc, 3, 3.
0	1	= 3, a!bc, 3, !abc.	0	1	= !abc, 3, 3, !abc.
1	0	= 3, abc!, 3, 3.	0	1	= !abc, a!bc, a!bc, !abc.

A summary of this strain is given in Table IV.

The points of interest to be noted in this table are as follows:

There are many supernumerary bristles in the flies of this strain.

The number of bristles added in the progeny of any mating is very variable and has no consistent relation to the visible character of the parents.

Addition of bristles tends very much to favor the females, reduction still affecting the males.

Despite the high ratio of bristles added, there are

TABLE IV

RECORD OF 1913-*E* STRAIN, *L. sericata* ♀ (3, 3, 3, 3) TAKEN AT THE BUSSEY INSTITUTION, FOREST HILLS, MASS., MARCH 19, 1913

Generation and Character of Matings	Progeny from Matings Recorded in First Column												
	Number of Flies Showing Bristles								Total Progeny	Bristles Lacking in "Decreased" Flies.		Bristles Added in "Increased" Flies	
	Normal		Decreased		Increased		Decreased and Increased						
	♂	♀	♂	♀	♂	♀	♂	♀		♂	♀	♂	♀
F_1 from mother = (3, 3, 3, 3)	38	43	0	0	1	0	0	0	82	0	0	1	0
F_2 from EF_1a = ♂ = 3, 3, ab ! c, 3, ♀ = 3, 3, 3, 3	69	76	0	0	1	1	0	0	147	0	0	1	2
F_3 from EF_2a = normal pair	318	251	3	1	44	91	1	0	709	4	0.5	75	170
F_4 from EF_3a = ♂ = 3, 3, 3, 3, ♀ = 3, 3, a ! bc, 3	191	100	0	0	36	53	0	1	381	0	1	73	111
F_4 from EF_3b = normal pair	41	57	0	0	3	3	0	0	104	0	0	3	8
Totals	657	527	3	1	85	148	1	1	1,423	4	1.5	153	291

nevertheless a few flies in the strain in which bristles are lacking.

Bristles normally present may be lacking in individuals having additional bristles.

General Summary and Conclusions

Taking a general summation of all the bred material of *Lucilia sericata,* we find that reduction affects the males while addition affects the females. Of the 5,367 flies bred, 2,708 are males and 2,659 are females, giving practical equality.

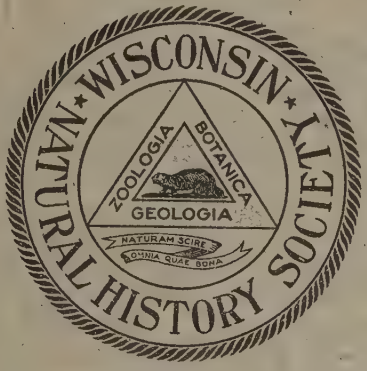
Reduction in the males is 748.5 bristles, while in the females it is only 455.5 bristles. As has been noted before the degree of reduction in the females is increased by the later generations of strain 1913—*A,* by reason of the fact that reduction rarely goes beyond the loss of two bristles in a single fly. Thus when most of the flies of a population become reduced to this extent it is evident that reduction in the males would be but slightly in advance of that in the females.

There are 210 bristles added in the males, while there are 343 added in the females. Thus addition affects the females more than the males. These figures for bristles added represent number of bristles, and thus no distinction is made between bristles of large and bristles of small size.

I wish to express my appreciation for the advice and criticism offered me in this work by Professor W. M. Wheeler, Messrs. H. D. Fish, S. G. Wright, and C. C. Little.

A Synonymic Catalogue of the Dipterous Family Phoridae

By
CHARLES T. BRUES



Reprinted from the Bulletin of the Wisconsin Natural History Society, Vol. XII, Nos. 3 and 4, pp 85–152

DATE OF PUBLICATION FEBRUARY 16, 1915

THE WAVERLY PRESS
BALTIMORE, U. S. A.

Reprinted from the Bulletin of the Wisconsin Natural History Society,
Vol. 12, Nos. 3 and 4, December, 1914

A SYNONYMIC CATALOGUE OF THE DIPTEROUS FAMILY PHORIDAE[1]

By Charles T. Brues

The present catalogue includes a complete list of the species so far described belonging to the *Phoridae* from all parts of the world, as well as the few fossil forms which have been given names. There has been very great activity during the past few years among a small number of taxonomists who have paid attention to this interesting family, resulting in the description of a large number of new species as well as a considerable series of new genera. Thus the number of known species has increased from about 150 to 472 within the last decade, while some 25 genera have been subdivded and added to till the number here listed has reached 46. Some are based on extremely aberrant forms, known in some cases only in the female sex, and it seems very probable that a part of these will be found in the future not to deserve generic rank. Some of the generic segregates of the old genus "Phora" also do not appear worthy of separation as genera, but as they have already become well established in the literature, only two or three of the least distinct have been suppressed in the present catalogue.

Most of the changes in generic and specific names already instituted by various authors from a strict application of the priority rules have been adopted, but I have been unable to subscribe to certain changes based on the papers of Rondani and Lioy. From a critical examination of the work of the latter author, it is very evident that in most cases he did not have before him the type species which he cites for his genera and there appears to be no means of now ascertaining upon what insects these names were based. Rondani's generic names have been lately accepted by Coquillett[2] but have since been disregarded by Malloch, Brues and

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 78.

[2] The Type-species of the North American Genera of Diptera. Proc. U. S. Nat. Mus., vol. 37, pp. 499-647, (1910).

others and I have not attempted to resurrect them at the present time, as like those of Lioy they give endless opportunity for opinionative discussion and disagreement. At most, but few changes in generic names could result, to whatever species these names should be attached.

The change of *Trineura* to *Phora*, which has been adopted by others appears in the following pages. It is an unfortunate change, but there can be no question of its propriety on nomenclatory grounds, as was pointed out years ago by the present writer.

Most of the genera listed seem to be fairly pure, with perhaps the exception of *Puliciphora* and *Dohrniphora*. The former is known mainly in the wingless female sex and from its cosmopolitan distribution is no doubt of polyphyletic origin. *Dohrniphora* includes a number of more or less heterogeneous types and is undoubtedly an artificial group which will probably later have to be subdivided in part and also partially merged with other genera. It was originally based on a rather peculiar species which has a number of close relatives, but now includes a majority of the species of the old genus "Phora" and some of the species referred to it in the following pages can be easily placed in doubtful cases only by the elimination of other related genera.

A number of very highly modified apterous types some of which are myrmecophilous or termitophilous are referred to a series of monotypical or very small genera. Many of these are known only as females and the discovery of winged males will probably show that the number of genera now recognized must be much reduced.

The geographical distribution of all of the larger genera is very extensive, remarkably so, considering the highly modified character of the family, and until more is known of the faunae of other regions beside Europe and North America no generalizations of importance can be made. A few common species have undoubtedly been widely disseminated through human agency.

The habits of the Phoridae are extremely varied, but the citations in the present catalogue have been restricted almost entirely to taxonomic references as the ethological data would have considerably increased its size. These have been recently summarized in a very brief way by Malloch[3] to whose paper the reader

[3] Proc. U. S. Nat. Mus., vol. 43, p. 520, (1912).

is referred. Mere mention in faunal lists has also usually been omitted unless of interest from the standpoint of distribution.

FAMILY PHORIDAE

Chaetoneurophora Malloch

1909. Glasgow Naturalist, vol. 1, p. 26. (*Chaetoneura*, nec Feld. Lepid. 1862)
1910. Malloch, Ann. Scottish Nat. Hist., p. 19. (*Chaetoneura*)
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 422.

Type: *C. caliginosa* Meig

aureiventris Brues. U. S. A.
Psyche, vol. 20, p. 90. (1913)

caliginosa Meigen. Europe.
Syst. Beschr., vol. 6, p. 214. (1830) (*Phora*)
Meigen, ibid., t.c., p. 215. (1830) (*Phora urbana*)
Macquart, Suit. à Buff., vol. 2, p. 627. (1835) (*Phora urbana*)
Bremi, Isis, p. 172. (1846) (*Phora*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2856. (1848) (*Trineura urbana*)
Gimmerthal, Arb. Naturf. Ver. Riga, vol. 1, p. 324. (1848) (*Phora*)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1136. (1849) (*Phora urbana*)
Zetterstedt, Dipt. Scand., vol. 8, p. 3365. (1849) (*Trineura*)
Zetterstedt, ibid, vol. 12, p. 4822. (1855) (*Trineura trochanterata*)
Schiner, Faun. Austr., vol. 2, p. 342. (1864) (*Phora urbana*)
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Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 21, fig. (1901) (*Phora urbana*)
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curvinervis Becker. Europe; N. Am.
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fennica Becker. Europe.
Abh. zool.-bot. Ges. Wien., vol. 1, p. 22. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 194, 266. (1906) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 424. (1912)

luggeri Aldrich. U. S. A.
Canadian Entom., vol. 24, p. 145. (1892) (*Phora*)
Coquillett, Canadian Entom., vol. 27, p. 104. (1895) (*Phora*)

Brues, Trans. Amer. Ent. Soc., vol. 29, p. 347, fig. (1903) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 424. (1912)

olympiae Aldrich. U. S. A.
Trans. Amer. Ent. Soc., vol. 29, p. 344, fig. (1904) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 424. (1912)

spinipes Coq. U. S. A.
Canadian Entom., vol. 27, p. 105. (1895) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 343, fig. (1903) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 425. (1912)

thoracica Meigen. Europe; N. Am.
Klass., vol. 1, p. 313. (1804) (*Trineura*)
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Fallen, Dipt. Suec. Phytom., p. 6. (1823) (*Trineura*)
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Meigen, ibid., vol. 6, p. 215. (1830) (*Phora dimidiata*)
Macquart, Suit. à Buff., vol. 2, p. 625, fig. (1835) (*Phora*)
Zetterstedt, Ins. Lapp, p. 795. (1838) (*Trineura*)
Blanchard, Hist. Nat. Ins., vol. 3, p. 630. (1840) (*Phora*)
Boitard, Nouv. Man. Entom., vol. 3, p. 521. (1843) (*Phora*)
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Zetterstedt, Dipt. Scand., vol. 7, p. 2852. (1848) (*Trineura*)
Zetterstedt, Dipt. Scand., vol. 7. p. 2853. (1848) (*Trineura dimidiata*)
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Walker, ibid, l. c. (1853) (*Phora dimidiata*)
Zetterstedt, Dipt. Scand., vol. 14, p. 6472. (1860) (*Trineura*)
Schiner, Faun. Austr., vol. 2, p. 342. (1864) (*Phora*)
Wulp, Tijdschr. Entom., vol. 14, p. 209. (1871) (*Phora*)
Neuhaus, Dipt. Marchica, p. 343. (1886) (*Phora*)
Strobl, Wien. Entom. Zeit., vol. 11, p. 196. (1892) (*Phora*)
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Brues, Trans. Amer. Ent. Soc., vol. 29, p. 342, fig. (1903) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 194. (1906) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 119. (1910) (*Phora dimidiata*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 423, fig. (1912)

thoracica Meig., var. **claripennis** Becker.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 20. (1901) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 119. (1910) (*Phora*)

trochanterata Zett. = *caliginosa* Meig.

urbana Meig. = *caliginosa* Meig.

variabilis Brues. U. S. A.
Journ. New York Entom. Soc., vol. 16, p. 199. (1908) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 423. (1912)

Paraspiniphora Malloch

1909. Glasgow Naturalist, vol. 1, p. 26. (*Spiniphora*, nec Mosel (Coel.) (1878)
1910. Malloch, Ann. Scottish Nat. Hist., p. 20. (*Spiniphora*)
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 425.

Type: P. *maculata* Meig.

bergenstammi Mik. Europe.
Verh. zool.-bot. Ges. Wien., vol. 14, p. 793. (1864) (*Phora*)
Strobl, Wien. Ent. Zeit., vol. 11, p. 197. (1892) (*Phora sphingicides*, nec Bouché)
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Wood, Entom. Monthly Mag., vol. 17, p. 196, 265. (1906) (*Phora domestica*)
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Keilin, Bull. Sci. France and Belgique, vol. 44, p. 31, fig. (1911) (*Phora*)
Wood, Entom. Monthly Mag., vol. 23, p. 95. (1912) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 426, fig. (1912)

bohemanni Becker. Europe.
Abh. zool.-bot. Ges. Wien., vol. 1, p. 27. (1901) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 427. (1912)

cockerelli Brues. Fossil; Florissant Miocene.
Bull. Amer. Mus., Nat. Hist., vol. 24, p. 274, fig. (1908) (*Phora*)

comstocki Aldrich = *bergenstammi* Mik.
Trans. Amer. Ent. Soc., vol. 29, p. 346. (1903) (*Phora*)

concinna Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 85, figs. (1909)

concitata Meunier. Fossil; Baltic Amber.
Jahrb. K. Pruess. Geol. Landesanst., vol. 30, p. 85, figs. (1909)

corrupta Meunier. Fossil; Baltic Amber.
Jahrb. K. Pruess. Geol. Landesanst., vol. 30, p. 89, figs. (1909)

domestica Wood. = *bergenstammi* Mik. England.
Entom. Monthly Mag., vol. 17, p. 262. (1906) (*Phora*)

dorsalis Becker. = *immaculata* Strobl.
Abh. zool.-bot. Ges. Wien., vol. 1, p. 31. (1901) (*Phora*)

erythronota Strobl. Europe.
Wiener, Entom. Zeitng., vol. 11, p. 195. (1892) (*Phora*)
Strobl, Mittheil. Naturwiss. Ver. Steiermark, vol. 30, p. 14. (1894) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien., vol. 1, p. 33, fig. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 262. (1906)
Malloch, Ann. Scottish Nat. Hist., p. 20. (1910) (*Spiniphora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 120. (1910) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 428. (1912)

erythronota Strobl, var. **nigrodorsata** Strobl. Europe.
Mitth. Naturwiss. Ver. Steiermark, vol. 46, p. 120. (1910) (*Phora*)
excisa Becker. Europe.
Abh. zool.-bot. Ges. Wien., vol. 1, p. 28. (1901) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 427. (1912)
fasciiventris Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 532, fig. (1911)
flavicornis Macquart, = *maculata* Meig.
Suit à Buff., vol. 2, p. 626. (1835) (*Phora*)
helicivora Dufour. = *maculata* Meig.
Soc. Sci. Lille, 1841, p. 420. (*Phora*)
immaculata Strobl. Europe.
Mitth. Ver. Steiermark, vol. 30, p. 14. (1894) (*Phora thoracica*, var. *immaculata*)
Becker, Abh. zool.-bot. Ges. Wien., vol. 1, p. 31. (1901) (*Phora dorsalis*)
Wood, Ent. Monthly Mag., vol. 17, p. 262, 265. (1906) (*Phora dorsalis*)
Malloch, Ann. Scottish Nat. Hist., p. 20. (1910) (*Spiniphora dorsalis*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 119. (1910) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 429. (1912) (*dorsalis*)
impedita Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 86, figs. (1909) (*Phora*)
? **laminarum** Brues. Fossil; Florissant Miocene.
Bull. Amer. Mus. Nat. Hist., vol. 24, p. 275, fig. (1908) (*Phora*)
maculata Meigen. Europe.
Syst. Reschr., vol. 6, p. 214. (1830) (*Phora*)
Fallen, Dipt. Suec. Phytom., p. 6. (1823) (*Trineura vulgaris*)
Macquart, Suit, à Buff., vol. 2, p. 626. (1835) (*Phora flavicornis*)
Meigen, Syst. Beschr., vol. 7, p. 418. (1838) (*Phora flavicornis*)
Dufour, Soc. Sci. Lille, 1841, p. 420, fig. (1841) (*Phora helicivora*)
Boitard, Nouv. Man. Entom., vol. 3, p. 521. (1843) (*Phora flavicornis*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2854. (1848) (*Trineura*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2855. (1848) (*Trineura notata*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2856. (1848) (*Trineura punctipennis*)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1135. (1849) (*Phora*)
Walker, Ins. Brit., vol. 2, p. 279. (1853) (*Phora*)
Schiner, Fauna Austriaca, vol. 2, p. 341. (1864) (*Phora*)
Wulp, Tijdschr. Entom., vol. 6, p. 208. (1871) (*Phora*)
Bigot, Ann. Soc. Ent. France, Bull., p. lxxvii. (1886) (*Phora helicivora*)
Becker, Abh, zool.-bot. Ges. Wien., vol. 1 p. 26, fig. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 262. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 20. (1910) (*Spiniphora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 119. (1910) (*Phora*)
Wood, Entom. Monthly Mag., vol. 23, p. 172, fig. (1912) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 426. (1912)

multiseriata Aldrich. U. S. A.
Trans. Amer. Ent. Soc., vol. 29, p. 345. (1904) (*Phora*)
Beutenmuller, Bull. Amer. Mus. Nat. Hist., vol. 20, p. 99. (1904) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 428, fig. (1912)

notata Zetterstedt. = *maculata* Meig.
Dipt. Scand., vol. 7, p. 2855. (1848) (*Trineura*)

pennsylvanica Malloch. U. S. A.
Entomol. News, vol. 25, p. 175. (1914)

petulans Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 84, figs. (1909) (*Phora*)

punctipennis Zetterstedt. = *maculata* Meig.
Dipt. Scand., vol. 7, p. 2856. (1848) (*Trineura*)

scutellata Brues. West Indies.
Trans. Amer. Ent. Soc., vol. 29, p. 344, fig. (1904) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 426. fig. (1912)

slossonae Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 428, fig. (1912)

sphingicides Strobl. = *bergenstammi*.
Wien. Ent. Zeit., vol. 11, p. 197. (1892) (nec Bouché) (*Phora*)

spinosissima Strobl. Europe.
Wien. Entom. Zeitng., vol. 11, p. 196. (1892) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 27. (1901) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 120. (1910) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 426, fig. (1912)

spinulosa Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 429, fig. (1912)

strobli Becker. Europe.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 36. (1901) (*Phora*)
Strobl, Wiener. Ent. Zeitng., vol. 11, p. 198. (1892) (*Phora fuscipes*, nec Macq.)
Strobl, Mitth. Naturwiss. Ver. Steiermark, vol. 30, p. 15. (1894) (*Phora fuscipes*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 36, fig. (1901) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 120. (1910) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 425. (1912)

trispinosa Malloch. Canada.
Proc. U. S. Nat. Mus., vol. 43, p. 427, fig. (1912)

unicalcarata Becker. Europe.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 32. (1901)

vulgaris Fallen. = *maculata* Meig.
Dipt. Suec. Phytom., p. 6. (1823) (*Trineura*)

Dohrniphora Dahl

1898. S. B. naturf. Freunde Berlin, 1898, No. 10, p. 188.
1901. Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 84.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 351.
1909. Malloch, Glasgow Natural., vol. 1, p. 27. (*Stenophora*)
1910. Malloch, Ann. Scottish Nat. Hist., p. 87. (*Phora*)
1910. Malloch, Ann. Scottish Nat. Hist., p. 89. (*Stenophora*)
1912. Malloch, Entom. News, vol. 23, p. 358.
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 412. (*Pseudostenophora*)
1913. Malloch, Psyche, vol. 20, p. 24.

Type: *D. dohrni* Dahl

abbreviata von Roser. Europe.
Württemb. Correspondbl., p. 64. (1840) (*Phora*)
Defour, Mém. Soc. Sci. Lille, p. 424, fig. (1841) (*Phora sordidipennis*)
Schiner, Faun. Austr., vol. 2, p. 344. (1864) (*Phora*)
Strobl, Wien. Ent. Zeitg., vol. 11, p. 197. (1892) (*Phora sordidipennis*)
Becker, Abh. zool.-bot. Ges. Wien., vol. 1, p. 22, fig. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 195, 265. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 88. (1910) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 119. (1910) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 431. (1912)

abdominalis Fallen.
Dipt. Suec. Phytom, p. 5. (1823) (*Trineura*)
Meigen, Syst. Reschr., vol. 6, p. 225. (1830) (*Phora*)
Curtis. Brit. Entom., p. 437. (1832) (*Phora*)
Haliday, Ent. Mag., vol. 1, p. 179. (1833) (*Phora*)
Guérin, Iconogr. Règne Anim. Ind., p. 555, fig. (1835) (*Phora*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2867. (1848) (*Trineura*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2868. (1848) (*Trineura palpina*)
Walker, List Dipt. Brit. Mus., vol. 4, p. 1135. (1849) (*Phora*)
Boheman, Vet. Acad. Handl., 1852, p. 20. (*Trineura fulviventris*)
Walker, Ins. Brit., vol. 2, p. 279. (1853) (*Phora*)
Zetterstedt, Dipt. Scand., vol. 12, p. 4824. (1855) (*Trineura fulviventris*)
Zetterstedt, Dipt. Scand., vol. 14, p. 6476. (1860) (*Trineura*)
Egger, Verh. zool.-bot. Ges. Wien., vol. 12, p. 1233 (1862) (*Phora flexuosa*)
Schiner, Faun. Austr., vol. 2, p. 336. (1864) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 338. (1864) (*Phora flexuosa*)
Schiner, Faun. Austr., vol. 2, p. 345. (1864) (*Phora palpina*)
Wulp, Tijdschr. Entom. (2), vol. 4, p. 209. (1871) (*Phora palpina*)
Giard, Traité d'Ent. Élémen., vol. 3, p. 1066. (1885) (*Phora*)
Strobl. Wien. Ent. Zeit., vol. 11, p. 197. (1892) (*Phora palpina*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 35, fig. (1901) (*Phora*)

Wood, Entom. Monthly Mag., vol. 17, p. 195, 265. (1906)
Becker, Zeits. Syst. Hym. & Dipt., vol. 7, p. 256. (1907) (*Phora flexuosa*)
Malloch, Ann. Scottish Nat. Hist., p. 88. (1910) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 120. (1910) (*Phora*)
Wood, Entom. Monthly Mag., vol. 23, p. 172, fig. (1912)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 430. (1912)
?Fabricius, Entom. Syst., vol. 4, p. 255. (1794) (*Bibio florea*)
?Meigen, Klassif., vol. 1, p. 217. (1804) (*Bibio florea*)
?Fabricius, Syst. Antl., p. 68. (1805) (*Bibio florea*)
?Meigen, Syst. Beschr., vol. 6, p. 221, fig. (1830) (*Phora florea*)
?Macquart, Suit à Buff., vol. 2, p. 629. (1835) (*Phora florea*)
?Walker, Lis. Dipt. Brit. Mus., vol. 4, p. 1137. (1849) (*Phora florea*)
?Walker, Ins. Brit., vol. 2, p. 280. (1853) (*Phora florea*)
?Schiner, Faun. Austr., vol. 2, p. 337. (1864) (*Phora florea*)
?Lioy, Atti. Inst. Ven., (3), vol. 10, p. 77. (1864) (*Diploneura florea*)
?Glover, Publ. Notes MS. Journ., p. 39. (1874) (*Phora florea*)
?Strobl, Wien. Ent. Zeitg., vol. 11, p. 193. (1892) (*Phora florea*)
?Strobl, Mitth. Naturwiss. Ver. Steiermark, vol. 30, p. 14. (1894) (*Phora florea*)

abducta Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 86, figs. (1909) (*Phora*)

ablata Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 87, figs. (1909) (*Phora*)

aequidistans Brunetti. India.
Rec. Indian Mus., vol. 7, p. 501. (1912) (*Phora*)

alaceris Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 83, figs. (1909) (*Phora*)

aptina Schiner. Europe.
Fauna Adelsb. Grotte, p. 18. (1853) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 340. (1864) (*Phora*)
Hamann, Europäische Höhlenfauna, p. 142. (1896) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 34, fig. (1901) (*Phora*)
Bezzi, Riv. Ital. Speleol. Bologna, vol. 1, p. 13. (1903) (*Phora*)
Florentin, Feuille Jeune Nat., vol. 34, p. 177. (1904) (*Phora*)
Brues, Bull. Wisconsin Nat. Hist. Soc., vol. 4, p. 102. (1906) (*Phora*)
Bezzi, Atti Soc. Ital. Soc. Sci. Nat., vol. 46, p. 11. (1907) (*Phora*)
Bezzi, Arch. Zool. Expér. and Gén., vol. 48, p. 15 and 53, g. (1911) (*Phora*)

autumnalis Becker. Europe.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 44, fig. (1901) (*Phora*)
Dahl, SB. Akad. Berlin, 1896, p. 21 (*Phora hiemalis* s. descr.)
Wood, Entom. Monthly Mag., vol. 17, p. 193, 265. (1906)
Malloch, Ann. Scottish Nat. Hist., 1910, p. 90. (*Stenophora*)

basalis Brunetti. India.
Rec. Indian Mus., vol. 7, p. 500. (1912) (*Phora*)

bicolorata Becker. Formosa.
Suppl. Entomologica, No. 3, p. 88, fig. (1914)

bispinosa Malloch. U. S. A.
Entomol. News, vol. 25, p. 173. (1914) (*Pseudostenophora*)
chlorogastra Becker. = *venusta* Coq.? Europe.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 32. (1901) (*Phora*)
cimbicis Aldrich = *concinna* Meig.
Canadian Entom., vol. 24, p. 143. (1892) (*Phora*)
cleghorni Bigot. India; Seychelles.
Indian Mus. Notes, vol. 1, p. 191. (1890) (*Phora*)
Wulp, Cat. Dipt. South Asia, p. 205. (1896) (*Phora*)
Collin, Trans. Linn. Soc. London, vol. 15, p. 106, fig. (1912)
cochlearipalpis Speiser. Germ. E. Afr.
Berliner Ent. Zeitschr., vol. 52, p. 146, fig. (1907)
Brues, Psyche, vol. 17, p. 36. (1910)
concinna Meigen. Europe, N. Am.
Syst. Beschr., vol. 6, p. 221.(No. 28) (1830) (*Phora*)
Meigen, Syst. Beschr., vol. 6, p. 221.(No. 30) (1830) (*Phora funebris*)
Meigen, Syst. Beschr., vol. 7, p. 412. (1838) (*Phora luctuosa*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2864. (1848) (*Trineura gymnophorina*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2875. (1848) (*Trineura*)
Walker, List Dipt. Brit. Mus., vol. 4, p. 1137. (1849) (*Phora funebris*)
Walker, Ins. Brit., vol. 2, p. 281. (1853) (*Phora funebris*)
Zetterstedt, Ibid., vol. 14, p. 6476. (1860) (*Trineura gymnophorina*)
Egger. Verh. zool.-bot. Ges. Wien, vol. 12, p. 1233. (1862) (*Phora distincta*)
Schiner, Faun. Austr., vol. 2, p. 338. (1864) (*Phora funebris*)
Scheiner, Faun. Austr., vol. 2, p. 338. (1864) (*Phora distincta*)
Schiner, Faun. Austr., vol. 2, p. 345. (1864) (*Phora*)
Neuhaus, Dipt. March., p. 344. (1886) (*Phora*)
Aldrich, Canad. Entom., vol. 24, p. 143. (1892) (*Phora cimbicis*)
Strobl, Wien. Ent. Zeit., vol. 11, p. 199. (1892) (*Phora pseudoconcinna*)
Strobl, Mitth. Ver. Steiermark, vol. 30, p. 15. (1894) (*Phora distincta*)
Coquillett, Canad. Entom., vol. 27, p. 104. (1895) (*Phora cimbicis*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 24, fig. (1901)
Becker, Ibid., t.c., p. 71. (1901) (*Phora funebris*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 348, fig. (1903) (*Phora cimbicis*)
Wood, Entom. Monthly Mag., vol. 17, p. 195. (1906) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 119. (1910) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 88. (1910) (*Phora*)
Wood, Entom. Monthly Mag., vol. 23, p. 172, fig. (1912) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 431. (1912)
conventa Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 535, fig. (1911)
crassicornis Meigen. Europe, N. Am.
Syst. Beschr., vol. 6, p. 220. (1830) (*Phora*)
Macquart, Suit. à Buff., vol. 2, p. 629. (1835) (*Phora*)

Zetterstedt, Dipt. Scand., vol. 7, p. 2874. (1848) (*Trineura*)
Walker, List Dipt. Brit. Mus., vol. 4, p. 1137. (1849) (*Phora*)
Walker, Ins. Brit., vol. 2, p. 280. (1853) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 344. (1864) (*Phora*)
Strobl, Wien. Ent. Zeit., vol. 11, p. 199. (1892) (*Phora*)
Strobl, Mitth. Naturwiss. Ver. Steiermark, vol. 30, p. 15. (1894) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 2, p. 23, fig. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 195. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 88. (1910) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 119. (1910) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 431. (1912)

dispar Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 20.

divaricata Aldrich. = *venusta* Coq. West Indies, New Guinea.
Trans. Ent. Soc. London, p. 437. (1896)

dohrni Dahl. Bismark Archipelago.
SB. naturf. Freunde, No. 10, p. 188, fig. (1898)
Dahl, Archiv f. Naturgesch., vol. 65, p. 75, fig. (1899)
Becker, Abh. zool.-bot. Ges. Wien., vol. 1, p. 84. (1901)
Brues, Ann. Mus. Nat. Hungarici, vol. 5, p. 401. (1907)
Brues, Ann. Mus. Nat. Hungarici, vol. 9, p. 437. (1911)

egregia Brues. Formosa, Java.
Ann. Mus. Nat. Hungarici, vol. 9, p. 534, fig. (1911) (*Phora*)

eridana Meunier. Fossil; Baltic Amber.
Jahbr. K. Preuss. Geol. Landesanst., vol. 30, p. 88, figs. (1909) (*Phora*)

flexuosa Egg. = *abdominalis* Fall.
Verh. zool.-bot. Ges. Wien., vol. 12, p. 1233. (1862) (*Phora*)

forcipata Strobl. Europe.
Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 118. (1910) (*Phora*)

florea Fabr. = ?*abdominalis* Fall.
Entom. Syst., vol. 4, p. 255. (1794) (*Bibio*)

fulviventris Bohem. = *abdominalis* Fall.
Vet. Akad. Handl., 1852, p. 20. (*Trineura*)

fuscohalterata Enderlein. Brazil.
Stettinger Ent. Zeit., 1912, p. 19.

gigantea Enderlein. Brazil.
Stettinger Ent. Zeit., 1912, p. 18.

hiemalis Dahl = *autumnalis* Becker.
SB. Akad. Berlin, 1896, p. 21. (1896) (*Phora*)

incisuralis Lw. U. S. A.
Cent. 7, p. 52. (1866) (*Phora*)
Aldrich, Canad. Ent., vol. 24, p. 143. (1892) (*Phora*)
Coquillett, ibid., vol. 27, p. 105. (1895) (*Phora*)
Coquillett, Proc. Acad. Nat. Sci. Philadelphia, p. 340. (1895) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 348, fig. (1903) (*Phora*)
Brues, Ann. Mus. Nat. Hung., vol. 3, p. 543. (1905) (*Phora*)
Brues, Ann. Mus. Nat. Hungarici, vol. 5, p. 401. (1907)

knabi Malloch. Panama.
Proc. U. S. Nat. Mus., vol. 43, p. 431. (1912)
meridionalis Brues. Paraguay.
Ann. Mus. Nst. Hungarici, vol. 9, p. 437. (1911)
mordax Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 531, fig. (1911)
nitida Malloch. Lourenzo Marques.
Proc. U. S. Nat. Mus., vol. 43, p. 511. (1912)
nitidifrons Brues. U. S. A.
Trans. Amer. Ent. Soc., vol. 29, p. 347, fig. (1904) (*Phora*)
Beutemnuller, Bull. Amer. Mus. Nat. Hist., vol. 20, p. 99. (1904) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 431. (1912) (*concinna*)
nudipalpis Becker. Europe.
Abh. zool.-bot. Ges. Wien., vol. 1, p. 29. (1901) ♂
Becker, idem, p. 30 ♀ (*unispinosa* pars)
Wingate, Entom. Monthly Mag., vol. 17, p. 110. (1906) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 193, 265. (1906)
Malloch, Ann. Scottish Nat. Hist., 1910, p. 90. (*Stenophora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 119. (1910) (*Phora*)
palpina Zett = *abdominalis* Fall.
Dipt. Scand., vol. 7, p. 2868. (1848) (*Trineura*)
papuana Brues. New Guinea.
Ann. Mus. Nat. Hungarici, vol. 3, p. 541. (1905) (*Phora*)
ibid., vol. 5, p. 401. (1907)
Collin, Trans. Linn. Soc. London, vol. 15, p. 107. (1912)
paraguayana Brues. Paraguay.
Ann. Mus. Nat. Hungarici, vol. 5, p. 400, fig. (1907)
pubericornis Malloch. Scotland.
Entom. Monthly Mag., vol. 18, p. 12. (1908) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., 1910, p. 90. (*Stenophora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 412. (1912) (*Pseudostenophora*)
rufithorax Brunetti. India.
Rec. Indian Mus., vol. 7, p. 502. (1912) (*Phora*)
setigera Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 24. (1914)
sinensis Schiner. Hongkong.
Dipt. Novara Reise, p. 224. (1868) (*Phora*)
De Meijere, Tidj. Entom., vol. 53, p. 106. (1910) (*Phora*)
sordidipennis Dufour = *abbreviata* v. Roser.
Mém. Soc. Sci. Lille, p. 424. (1841) (*Phora*)
sororcula v.d. Wulp. Europe.
Tijdschr. v. Ent., vol. 14, p. 209. (1871)
Strobl, Mittheil. Naturwiss. Ver. Steiermark, vol. 30, p. 15. (1895) (*Phora distinguenda*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 45. (1901)

trepida Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 88, figs. (1909)
unispinosa Zetterstedt. Europe.
Dipt. Scand., vol. 14, p. 6475. (1860) (*Trineura*)
Strobl, Wien Ent. Zeit., vol. 11, p. 198. (1892) (*Phora distinguenda*)
Becker, Abh. zool.-bot. Ges., Wien, vol. 1, p. 30, fig. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 193, 265. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., 1910, p. 90. (*Stenophora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 119. (1910) (*Phora*)
venusta Coq. U. S. A.
Canadian Entom., vol. 27, p. 107. (1895) (*Phora*)
Aldrich, Trans. Ent. Soc. London, 1896, p. 437. (*Phora divaricata*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 346. (1903) (*Phora*)
Brues, Ann. Mus. Nat. Hungarici, vol. 3, p. 542. (1905) (*divaricata*)
Collin, Trans. Linn. Soc. London, vol. 15, p. 107. (*chlorogastra*) (1912)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 432. (1912)
Weiss, Algér, Bull. Soc. Hist. Nat., 1911, p. 34. (1912) (*chlorogastra*)
venusta Coq. var. **buscki** Malloch. Panamá
Proc. U. S. Nat. Mus., vol. 45, p. 432. (1912)
venusta Coq., var. **perplexa** Brues. U. S. A.
Trans. Amer. Ent. Soc., vol. 29, p. 350. (1904) (var. of *P. divaricata Ald*)
Collin, Trans. Linn. Soc. London, vol. 15, p. 107. (1912)
vetusta Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 84. (1909)
vincta Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 89, figs. (1909)

Crepidopachys Enderlein

1912. Stettiner Ent. Zeit., p. 16, fig.
1913. Malloch, Psyche, vol. 20, p. 23.

Type: *C. longirostrata*

costalis Enderlein
(see note under *C. longirostrata*)
longirostrata Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 17, fig. (legend under figure reads *C. costalis* Enderl.)
Malloch, Psyche, vol. 20, p. 23. (1913)

Trupheoneura Malloch

1909. Glasgow Naturalist, vol. 1, p. 27.
1910. Malloch, Ann. Scottish Nat. Hist., p. 88.
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 417.

Type: *T. perennis* Meigen

bicornuta Strobl. Europe.
Mitth. Naturwiss. Ver. Steiermark, vol. 46, p. 117. (1910) (*Phora*)
fratercula Brues. U. S. A.
Trans. Amer. Ent. Soc., vol. 29, p. 341, fig. (1904) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 420. (1912)
intermedia Malloch. England.
Entom. Monthly Mag., vol. 19, p. 204. (1908)
Malloch, Ann. Scottish Nat. Hist., p. 89. (1910)
lugubris Meig. Europe.
Syst. Beschr., vol. 6, p. 217. (1830)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1136. (1849) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 18. (1901) (*Phora*)
Wingate, Entom. Monthly Mag., vol. 17, p. 111 and 215. (1906) (*papillata*)
Wood, Entom. Monthly Mag., vol. 17, p. 192 and 265. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 89. (1910)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 119. (1910) (*Phora*)
luteifemorata Wood. England.
Entom. Monthly Mag., vol. 17, p. 191 and 265. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 89. (1910)
microcephala Lw. U. S. A.
Cent. 7, p. 51. (1866)
Aldrich, Canad. Ent., vol. 24, p. 143. (1892)
Coquillett, Canad. Ent., vol. 27, p. 104. (1895) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 342. (1903) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 421. (1912)
nigricornis Egg. = *opaca* Meig. Europe.
Verh. zool.-bot. Ges. Wien, vol. 12, p. 1235. (1862)
nudicosta Brues. India.
Ann. Mus. Nat. Hungarici, vol. 5, p. 404, fig. (1907)
occidentalis Brues. U. S. A.
Journ. New York Entom. Soc., vol. 16, p. 200. (1908) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 417. (1912)
opaca Meigen
Syst. Beschr., vol. 6, p. 216. (1830) (*Phora*)
Macquart, Suit. à Buff., vol. 2, p. 647. (1835) (*Phora*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2866. (1848) (*Trineura*)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1136. (1849) (*Phora*)
Egger, Verh. zool.-bot. Ges. Wien, vol. 12, p. 1235. (1862) (*Phora nigricornis*)
Schiner, Faun. Austr., vol. 2, p. 342. (1864) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 342. (1864) (*Phora nigricornis*)
Wulp, Tijd. v. Entom., vol. 14, p. 208. (1871) (*Phora*)
Neuhaus, Dipt. March., p. 343. (1886) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 17. (1901) (*Phora*)

Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 18, fig. (1901) (*Phora nigricornis*)
Czerny, Verh. zool.-bot. Ges. Wien, vol. 53, p. 238. (1903) (*Phora*)
Wingate, Entom. Monthly Mag., vol. 17, p. 110. (1906) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, pp. 189, 192, 264. (1906) (*Phora*)
Collin, Entom. Monthly Mag., vol. 17, p. 177. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 89. (1910)
Strobl. Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 119. (1910) (*Phora nigricornis*)

pachyneura Lw. U. S. A.
Cent. 7, p. 52. (1866) (*Phora*)
Aldrich, Canadian Entom., vol. 24, p. 142. (1892) (*Phora*)
Coquillett, Canadian Entom., vol. 27, p. 104. (1895) (*Phora pachyneuron*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 341, fig. (1903) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 418. (1912)

palposa Zett. Europe.
Dipt. Scand., vol. 7, p. 2870. (1848) (*Trineura*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 16, fig. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 190, 264. (1906)
Malloch, Ann. Scottish Nat. Hist., p. 88. (1910)

papillata Wingate. = *lugubris* Meig
Entom. Monthly Mag., vol. 17, p. 11. (1906) (*Phora*)

perennis Meigen. Europe.
Syst. Beschr., vol. 7, p. 412. (1838) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 345. (1864) (*Phora*)
Hofmann, Ann. Soc. Ent. Belgique, vol. 30, C. R., p. cxxxi. (1886) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 18. (1901) (*Phora opaca* pars)
Collin, Entom. Monthly Mag., vol. 17, p. 177. (1906) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 189, 192, 264. (1906)
Malloch, Ann. Scottish Nat. Hist., p. 89. (1910)
Wood, Entom. Monthly Mag., vol. 17, p. 191, 264. (1906) (*Phora*)

subfusca Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 422. (1912)

sublugubris Wood. England.
Entom. Monthly Mag., vol. 17, p. 192 and 265. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 89. (1910)

suspecta Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 421. (1912)

territa Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 82, fig. (1909) (*Phora*)

trinervis Becker. Europe.
Abh. zool.-bot. Ges. Wien., vol. 1, p. 19. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 191. (1906) (*Phora*)
Strobl. Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 117. (1910) (*Phora*)

varipes Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 419. (1912)
vitrea Wood. England.
Entom. Monthly Mag., vol. 17, p. 191, 265. (1906) (*Phora*)
Becker. Abh. zool.-bot. Ges., vol. 1, p. 17. (1901) (*Phora opaca* pars)
Wood, Entom, Monthly Mag., vol. 23, p. 172, fig. (1912) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 89. (1910)
vitrinervis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 419, fig. (1912)

Parastenophora Malloch

1909. Malloch, Glasgow Natural, vol. 1, p. 28 (*Woodia*, nec Deshayes, 1860, Mollusca)
1910. Malloch, Ann. Scottish Nat. Hist., p. 90

Type: *P. gracilis* Wood

gracilis Wood. England.
Entom. Monthly Mag., vol. 18, p. 228. (1907) (*Phora*)
Wood, ibid., vol. 23, p. 94. (1912) (*Phora*)
?nigrocincta De Meijere. Europe.
Tijdschr. v. Entom., vol. 50, p. 189. (1907) (*Phora*)

Phorhynchus Brunetti

1912. Rec. Indian Mus., vol. 7, p. 504.

Type: *P. ater* Brunetti

ater Brunetti. Ceylon.
Rec. Indian Mus., vol. 7, p. 504. (1912)

Hypocera Lioy

1864. Atti. Inst. Venet, vol. 10, p. 78.
1864. Lioy, ibid., l.c. (nec Vieill., Aves). (*Nemosia*)
1864. Lioy, ibid., p. 79. (*Gymnoptera*)
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 351.
1906. Brues, Genera Ins., fasc. 44, p. 6.
1908. Brues, in Williston's Man. N. Amer. Dipt., Ed. 3, p. 239.
1909. Malloch, Glasgow Naturalist, vol. 1, p. 26.
1910. Malloch, Ann. Scottish Nat. Hist., p. 18.
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 433.

Type: *H. mordellaria* Fall

angustifrons Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 43.
agilis Meigen. Europe.
Syst. Beschr., vol. 6, p. 213. (1830) (*Phora*)
Macquart, Suit. à Buff., vol. 2, p. 630. (1835) (*Phora*)

Zetterstedt, Dipt. Scand., vol. 7, p. 2835. (1848) (*Trineura carinifrons*) ♀ non ♂.
Schiner, Faun. Austr., vol. 2, p. 339. (1864) (*Phora*)
Lioy, Atti Instit. Ven., vol. (13) 10, p. 78. (1864)
Neuhaus, Dipt. March., p. 342. (1886) (*Phora*)
Strobl, Wien. Ent. Zeit., vol. 11, p. 193. (1892) (*Phora*)
Strobl, Mittheil. Naturwiss. Ver. Steiermark, vol. 30, p. 14. (1894) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien., vol. 1, p. 42, fig. (1901) (*Phora*)
Strobl. Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 116. (1910) (*Phora*)

bernuthi Egg. Europe.
Verh. zool.-bot. Ges. Wien, vol. 12, p. 1234. (1862) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 339. (1864) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 38. (1901) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 434. (1912)

carinifrons Zetterstedt. Europe.
Dipt. Scand., vol. 7, p. 2885. (1848) ♂ non ♀. (*Trineura*)
Becker, Abh. zool.-bot. Ges. Wien. vol. 1, p. 38, fig. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 263. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 19. (1910)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 434. (1912)

citreiformis Becker. Europe.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 43, fig. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 264, 266. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 19. (1910)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 435. (1912)

clavata Lw. U. S. A.
Cent. 7, p. 51. (1866) (*Phora*)
Aldrich, Canad. Ent., vol. 24, p. 142. (1892) (*Phora*)
Coquillett, Canad. Ent., vol. 27, p. 104. (1895) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 355, fig. (1903)
Motter, Journ. New York Entom. Soc., vol. 6, p. 223. (1898) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 435. (1912)

convergens Malloch. Panama.
Proc. U. S. Nat. Mus., vol. 43, p. 435. (1912)

coronata Becker. Europe.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 41. (1901) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 353. (1903)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 116. (1910) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 434. (1912)

crassineura Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 25. (1914)

crassinervis Strobl. Europe.
Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 116. (1910) (*Phora*)

difformis Brues. New Guinea.
Ann. Mus. Nat. Hungarici, vol. 3, p. 543, fig. (1905)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 433. (1912)

ehrmanni Aldrich. U. S. A.
Trans. Amer. Ent. Soc., vol. 29, p. 353, fig. (1904)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 435. (1912)
femorata Meig. = *flavimana* Meig.
Syst. Beschr., vol. 6, p. 213. (1830) (*Phora*)
flavimana Meigen. Europe; N. America.
Syst. Beschr., vol. 6, p. 213, no. 4. (1830) (*Phora*)
Meigen, loc. cit., no. 5. (1830) (*Phora femorata*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2886. (1848) (*Trineura femorata*)
Zetterstedt, ibid., vol. 14, p. 6479. (1860) (*Trineura femorata*)
Schiner, Faun. Austr., vol. 2, p. 339. (1864) (*Phora femorata*)
Neuhaus, Dipt. March., p. 342. (1886) (*Phora*)
Howard, Proc. Washington Acad. Sci., vol. 2, p. 598. (1900) (*Phora femorata*)
Coquillett, Canadian Entom., vol. 27, p. 104. (1895) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 41, fig. (1901) (*Phora femorata*
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 354. (1903) (*femorata*)
Wood, Entom. Monthly Mag., vol. 17, p. 264, 266. (1906) (*Phora femorata*)
Strobl, Mitt. Naturwiss, Ver. Steiermark, vol. 46, p. 116. (1910) (*Phora femorata*)
Wood, ibid., vol. 23, p. 96. (1912) (*Phora femorata*)
Malloch, Ann. Scottish Nat. Hist., p. 19. (1910) (*femorata*)
Bezzi, Arch. zool. Expér. & Gén., vol. 48, p. 59. (1911)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 434. (1912)
flavipalpis Macquart. = *?mordellaria* Fall. France.
Suit. à Buff., vol. 2, p. 626. (1835) (*Phora*)
Meigen, Syst. Beschr., 7, p. 413. (1838) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 40. (1901) (*Phora*)
grenadensis Brues. West Indies.
Trans. Amer. Ent. Soc., vol. 29, p. 356, fig. (1904)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 434. (1912)
incrassata Meigen.
Syst. Beschr., vol. 6, p. 212, fig. (1830) (*Phora*)
Macquart, Suit à Buff., vol. 2, p. 630. (1835) (*Phora*)
Boitard, Nouv. Man. Entom., vol. 3, p. 522. (1843) (*Phora*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2882. (1848) (*Trineura*)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1135. (1849) (*Phora*)
Walker, Ins. Brit., vol. 2, p. 281, fig. (1853) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 339. (1864) (*Phora*)
Lioy, Atti. Instit. Ven., vol. (3) 10, p. 78. (1864) (*Nemosia*)
Assmuss, Parasiten der Honigbiene, p. 27, fig. (1865) (*Phora*)
Glover, Publ. MS. Notes from my Journ., p. 40, fig. (1874) (*Phora*)
Neuhaus, Dipt. March., p. 341. (1886) (*Phora*)
Leonardi, Insetti Nosisi, Napoli, vol. 3, p. 212. (1900) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 37, fig. (1901) (*Phora*)

Wood, Entom. Monthly Mag., vol. 17, p. 263. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 19. (1910)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 117. (1910) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 434. (1912)

insperata Brues. Paraguay.
Ann. Mus. Nat. Hungarici, vol. 9, p. 439. (1911)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 434. (1912) (*inseparata*)

irregularis Wood. England.
Ent. Month. Mag., vol. 23, p. 95, fig. (1912) (*Phora*)

johnsoni Brues. U. S. A.; Nicaragua.
Trans. Ent. Soc., vol. 29, p. 352, figs. (1904)
Malloch, Bull. U. S. Nat. Mus., vol. 43, p. 434. (1912)

marginata Brunetti. India.
Rec. Indian Mus., vol. 7, p. 512. (1912)

minor Strobl = *vitripennis* Meig.
Programm Seitenst., vol. 14, p. 40. (1880) (*Phora*)

mordellaria Fallen. Europe; N. Am.?
Dipt. Suec. Phytom., p. 6. (1823) (*Trineura*)
Meigen, Syst. Beschr., vol. 6, p. 212. (1830) (*Phora*)
Macquart, Suit. à Buff., vol. 2, p. 630. (1835) (*Phora*)
Boitard, Nouv. Man. Entom., vol. 3, p. 521. (1843) (*Phora flavipalpis*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2883. (1848) (*Trineura*)
Zetterstedt, ibid., vol. 8, p. 3365. (1849) (*Trineura*)
Haliday, Stettiner. Ent. Zeitg., vol. 12, p. 144. (1851) (*Phora*)
Zetterstedt, Dipt. Scand., vol. 14, p. 6478. (1860) (*Trineura*)
Schiner, Faun. Austr., vol. 2, p. 339. (1864) (*Phora*)
Lioy, Atti. Istit. Venet., vol. (3) 10, p. 74. (1864)
Neuhaus, Dipt. March., p. 341. (1886) (*Phora*)
?Coquillett, Canadian Entom., vol. 27, p. 104. (1895) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 40, fig. (1901) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 355. (1903)
Wood, Entom. Monthly Mag., vol. 17, p. 263. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 19. (1910)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 434. (1912)

puerilis Becker. Madeira.
Mitt. Zool. Mus. Berlin, vol. 4, p. 194. (1908) (*Phora*)

rectangulata Malloch. Java.
Proc. U. S. Nat. Mus., vol. 43, p. 435, 512, fig. (1912)

suspecta Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 537, fig. (1911)

theodori Dahl. Europe.
Faun. Chorin, p. 364 (26) and 462 (124). (1912) (*Phora*)

vectabilis Brues. Abyssinia.
Ann. Mus. Nat. Hungarici, vol. 11, p. 1. (1913)

vitripennis Meigen. Europe.
Syst. Beschr., vol. 6, p. 223. (1830) (*Phora*)
Macquart, Suit. à Buff., vol. 2, p. 631. (1834) (*Phora*)

?Zetterstedt, Dipt. Scand., vol. 7, p. 2889. (1848) (*Trineura*)
Lioy, Atti. Istit. Venet., vol. (3) 10, p. 79. (1864) (*Gymnoptera*)
Strobl, Program Seitenst., vol. 14, p. 40. (1880) (*Phora minor*)
Strobl Wien. Ent. Zeitg., vol. 11, p. 193. (1892) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 35, fig. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 17, p. 264, 266. (1906) (*Phora*)
Malloch, Ann. Scottish Nat. Hist., p. 19. (1910)
Strobl. Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 116. (1910) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 434. (1912)
vitripennis, var. **albohalterata** Strobl. Europe.
Wien. Entom. Zeitg., vol. 11, p. 194. (1892) (*Phora*)

Hypocerina Malloch

1913. Psyche, vol. 20, p. 24, fig.

Type: *H. barberi* Malloch

barberi Malloch. U. S. A.
Psyche, vol. 20, p. 25. (1913)

Syneura Brues

1903. Trans. Amer. Ent. Soc., vol. 29, p. 383.
1906. Brues. Genera Ins., fasc. 44, p. 12.
1908. Brues, in Williston's Man. N. Amer. Dipt., Ed. 3, p. 239.
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 503.

Type: *S. cocciphila* Coquillett

cocciphila Coquillett. Mexico.
Canadian Entom., vol. 27, p. 106. (1895)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 383. (1903)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 503. (1912)
?**orientalis** De Meijere. Java.
Tijd. Entom., vol. 50, p. 253. (1907)

Platyphora Verrall

1877. Journ. Linn. Soc., London, Zool., vol. 13, p. 259.
1901. Becker, Abh. zool.-bot. Ges. Wien., vol. 1, p. 88.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 386.
1906. Brues, Genera Insectorum, fasc. 44, p. 13.
1908. Enderlein, Zool. Jahrb. Abth. f. Syst., vol. 27, p. 148.
1910. Malloch, Ann. Scottish Nat. Hist., p. 17.
1912. Becker, Wiener Ent. Zeit., vol. 31, p. 329. (*Psalidesma*)
1913. Becker, ibid., vol. 32, p. 19.
1914. Brues, Psyche, vol. 21, p. 76.

Type: *P. lubbocki* Verrall

coloradensis Brues. U. S. A.
Psyche, vol. 21, p. 79. (1914)
eurynota Brues. U. S. A.
Psyche, vol. 21, p. 77. (1914)
lubbocki Verrall. England.
Journ. Linn. Soc., vol. 13, p. 259. (1877)
Lubbock, Ants, Bees & Wasps, p. 371. (1883)
Bezzi. Rendic. Istit. Lomb. Sc. Lett., vol. 33, p. 11. (1900)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 88. (1901)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 316. (1903)
Shelford, Journ. Linn. Soc. London, Zool., vol. 30, p. 152. (1908)
Enderlein, Zool. Jahrb. Abth. f. Syst., vol. 27, p. 148. (1908)
Becker, Wien. Ent. Zeitg., vol. 32, p. 19. (1913)
Brues, Psyche, vol. 21. p. 76. (1914)
pyrenaica Becker. S. W. Europe.
Wiener. Ent. Zeit., vol. 31, p. 330, figs. (1912) (*Psalidesma*)
Becker, ibid., vol. 32, p. 19. (1913)
Brues, Psyche, vol. 21, p. 76. (1914)

Conoprosopa Becker

1909. Bull. Mus. Hist. Nat. Paris, p. 113.
1910. Brues, Psyche, vol. 17, p. 34. (*Coryptilomyia*)
1910. Becker. Ann. Soc. Ent. France, vol. 29, p. 30.
1912. Enderlein. Stettiner Ent. Zeit., p. 51. (*Metopotropis*)
1912. Brues, Psyche, vol. 19, p. 135.

Type: *C. scutellata* Becker

armigera Brues. Natal.
Psyche, vol. 17, no. 1, p. 35, fig. (1910) (*Coryptilomyia*)
herero Enderlein. German Southwest Africa.
Stettinger Ent. Zeit., 1912, p. 52. (*Metopotropis*)
scutellata Becker. Southern Ethiopia.
Bull. Mus. Hist. Nat. Paris, 1909, p. 113. (1909)
Ann. Soc. Entom. France, vol. 29, p. 30. (1910)
Brues, Psyche, vol. 19, p. 135. (1910)

Conicera Meigen

1830. Syst. Beschr. zweifl. Ins., vol. 6, p. 226, pl. lxiii, figs. 12, 13.
1835. Macquart, Hist. Nat. Dipt., vol. 2, p. 631, pl. xxiv, fig. 6.
1840. Westwood, Introd, Mod. Class. Ins., vol. 2, p. 154. (1840)
1864. Schiner Faun. Austr., Dipt., vol. 2, p. 335.
1901. Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 80, pl. iii, fig. 59.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 379, figs. 54–56.
1908. Brues, in Williston's Man. N. Amer. Dipt., Ed. 3, p. 239.

1910. Malloch, Ann. Scottish Nat. Hist., p. 17.
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 436.

Type: *C. dauci* Meig.

albipennis Meigen = *dauci* Meigen.
Syst. Beschr., vol. 6, p. 223, no. 35. (1830) (*Phora*)
aldrichii Brues. U. S. A.
Trans. Amer. Ent. Soc., vol. 29, p. 379, fig. (1903)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 437. (1912)
atra Meigen = *dauci* Meigen.
Syst. Beschr., vol. 6, p. 226, fig. (1830)
bicolor Brues. Malay Peninsula.
Ann. Mus. Nat. Hungarici, vol. 3, p. 553. (1905)
dauci Meigen. Europe; N. Amer.
Syst. Beschr., vol. 6, p. 223, no. 34. (1830) (*Phora*)
Meigen, ibid., t.c., p. 223, no. 35. (1830) (*Phora albipennis*)
Meigen, ibid., t.c., p. 226, fig. (1830) (*atra*)
Haliday, Ent. Mag., vol. 1, p. 179. (1833) (*Phora*)
Bouché, Naturg, p. 101, fig. (1834) (*Phora*)
Macquart, Suit. à Buff., vol. 2, p. 630. (1835) (*Phora*)
Macquart, ibid, t.c., p. 632 and 666, fig. (1836) (*atra*)
Meigen, Syst. Beschr., vol. 7, p. 411. (1838)
Westwood, Introd. Mod. Class. Ins., vol. 2, p. 575, fig. (1840) (*Phora*)
Blanchard, Hist. Nat. Ins., vol. 3, p. 630. (1840) (*atra*)
Boitard, Nouv. Man. Entom., vol. 3, p. 522. (1843) (*Phora*)
Boitard, ibid., t.c., p. 523. (*atra*) (1843)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1138. (1849) (*Phora*)
Walker, Ins. Brit., vol. 2, p. 281, fig. (1853) (*Phora atra*)
Schiner, Faun. Austr., vol. 2, p. 335. (1864) (*atra*)
Lioy, Atti. Istit. Ven. (3), vol. 10, p. 78. (1864) (*Hypocera*)
Glover, Publ. MS. Notes from my Journ., p. 39, fig. (1874) (*Phora*)
Perris, Ann. Soc. Ent. France, vol. 6, p. 233. (1876) (*atra*)
Neuhaus, Dipt. March., p. 341. (1882) (*atra*)
Hofmann, Ann. Soc. Ent. Belgique, vol. 30, C. R., p. cxxxi. (1886) (*Phora albipennis*)
Reinhardt, Verh. zool.-bot. Ges. Wien, vol. 31, p. 207. (1888) (*atra*)
Webster, Ins. Life, vol. 2, p. 356. (1890) (*atra*)
Kowarz, Flieg. Böhmens, p. 69. (1894) (*Phora nickerli*)
Mik, Wien. Entom. Zeitg., vol. 13, p. 22. (1894) (*Phora nickerli*)
Riley & Howard, Ins. Life, vol. 2, p. 351. (1900) (*atra*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 81, fig. (1901) (*atra*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 380, fig. (1903) (*atra*)
Malloch, Ann. Scottish Nat. Hist., p. 17. (1910) (*atra*)
Strobl, Mitt. Naturwiss. Ver. Steiermark. vol. 46, p. 116. (1910) (*atra*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 437. (1912) (*atra*)
eocenia Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geolog. Landesanst., vol. 30, p. 78, figs. (1909)

formosensis Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol 9, p. 539, fig. (1911)
kerteszii Brues. Peru.
Ann. Mus. Nat. Hungarici, vol. 3, p. 399. (1905)
neotropica Brues. Grenada, B. W. I.
Trans. Amer. Ent. Soc., vol. 29, p. 380. (1904) (var. of *atra*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 437. (1912)
nickerli Kowarz = *dauci* Meig.
Fleig. Bohmens, p. 69. (1894) (*Phora*)
similis Halid. Europe.
Entom. Monthly Mag., vol. 1, p. 179. (1833) (*Phora*)
Walker, Ins. Brit., vol. 2, p. 281. (1835) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 81. (1901)
Malloch, Ann. Scottish Nat. Hist., p. 17. (1910)
simplex Brues. New Guinea.
Ann. Mus. Nat. Hungarici, vol. 3, p. 553. (1905)

Phora Latreille

1796. Précis, p. 169 (no species included).
1802. Latreille Hist. Nat. Crust. Ins., vol. 3, p. 464.
1803. Schellenberg. Genres Mouches Dipt., pl. 12, fig. 1. (*Noda*)
1803. Meigen, Illiger's Mag., vol. 2, p. 276. (*Trineura*)
1804. Latreille, Hist. Nat. Crust. Ins., vol. 14, p. 394.
1804. Meigen, Klassif., vol. 1, p. 312. (*Trineura*)
1823. Fallen, Dipt. Suec. Phytom., p. 7. (*Trineura*)
1848. Zetterstedt, Dipt. Scand., vol. 7, p. 2890. (*Trineura*)
1856. Rondani. Dipt. Ital. Prodr., vol. 1, p. 137. (*Philodendria*)
1864. Lioy. Atti. Instit. Venet., (3), vol. 10, p. 77.
1864. Schiner, Faun. Austr., vol. 2, p. 347. (*Trineura*)
1901. Becker, Abh. Zool.-bot. Ges. Wien, vol. 1, p. 78. (*Trineura*)
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 339. (*Trineura*)
1906. Brues, Genera. Ins., fasc. 44, p. 7. (*Trineura*)
1908. Brues, in Williston's Man. N. Amer. Dipt., Ed. 3, p. 239.
1910. Malloch, Ann. Scottish Nat. Hist., p. 18. (*Trineura*)
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 437.

Type: P. *aterrima* Fabr.

anthracina Curtis. = *aterrima* Fabr.
Guide, Ed. 2, p. 377. (1873) (*Phora*)
aterrima Fabricius. Europe; N. Amer.
Ent. Syst., vol. 4, p. 334. (1794) (*Musca*)
Geoffroy, Hist. Ins., vol. 2, p. 533. (1764) (sine nom.)
Latreille, Hist. Nat. Crust. Ins., vol. 3, p. 464. (1802)
Meigen, Klass., vol. 1, p. 313, fig. (1803) (*Trineura atra*)
Latreille, Dict. Hist. Nat., vol. 24, p. 197. (1804) (*Phora*)
Coquebert, Illustr. Icon. Insect, p. 106, fig. (1804) (*Musca*)

Latreille, Hist. Nat. Crust. Ins., vol. 14, p. 394. (1804)
Fabricius, Syst. Antliat., p. 323. (1805) (*Tephritis*)
Latreille, Gen. Crust. Ins., vol. 4, p. 360. (1809)
Fallen, Dipt. Suec. Phytom., p. 7. (1823) (*Trineura atra*)
St. Farg. & Serv., Encycl. Méthod., vol. 10, p. 112. (1825)
Boitard, Man. Entom., vol. 2, p. 398. (1828)
Meigen, Syst. Beschr., vol. 6, p. 224. (1830)
Meigen, Syst. Beschr., vol. 6, p. 225. (1830) (*stictica*)
Haliday, Ent. Mag., vol. 1, p. 179. (1833)
Macquart, Suit. à Buff., vol. 2, p. 629, fig. (1835)
Macquart, ibid., t.c., Expl. Plate 24. (1835) (*P. nigerrima*)
Zetterstedt, Ins. Lapp., p. 796. (1838) (*Trineura*)
Zetterstedt, ibid., p. 797. (1838) (*Trineura stictica*)
Boitard, Nouv. Man. Entom., vol. 3, p. 522. (1843)
Zetterstedt, Dipt. Scand., vol. 7, p. 2890. (1848) (*Trineura*)
Zetterstedt, ibid., t.c., p. 2893. (1848) (*Trineura stictica*)
Zetterstedt, ibid., t.c., p. 2884. (1848) (*Trineura obscura*)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1138. (1849)
Walker, ibid., l.c. (1849) (*stictica*)
Walker, Ins. Brit., vol. 2, p. 281. (1853)
Schiner, Faun. Austr., vol. 2, p. 347. (1864) (*Trineura*)
Schiner, Dipt. Novara Reise, p. 223. (1868) (*Trineura*)
Curtis, Guide, Ed. 2, p. 277. (1873) (*anthracina*)
Osten Sacken, Cat. N. Am. Dipt., Ed. 2, p. 212. (1878)
Girschner, Entom. Nachr., vol. 9, p. 204. (1883) (*Trineura*)
Girschner, ibid., l.c. (1883) (*Trineura stictica*)
Strobl, Wien. Ent. Zeitg., vol. 11, p. 204. (1892) (*Trineura*) (also as *stictica*)
Mégnin, La Nature, vol. 16, p. 275. (1888)
Mégnin, Rev. Sci. Bourb., vol. 1, p. 261. (1888)
Mik, Wien. Ent. Zeitg., vol. 9, p. 294. (1890) (*stictica*)
Strobl, Mitth. Ver. Steierm., vol. 30, p. 17. (1893) (*Trineura stictica*)
Coquillett, Canadian Entom., vol. 27, p. 103. (1895) (*Trineura atra*)
Strobl, Wien. Ent. Zeitg., vol. 18, p. 148. (1899) (*Trineura*) (as *stictica* also)
Coquillett, Proc. Washington Acad. Sci., vol. 2, p. 437. (1900) (*Trineura*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 72 and 80, fig. (1901) (*Trineura*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 377, fig. (1903) (*Trineura*)
Coquillett, Dipt. Harriman Alaska Exped., vol. 9, pt. 2, p. 5. (1904) (*Trineura*)
Malloch, Ann. Scottish Nat. Hist., p. 18. (1910)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 439. (1912)

atra Fallen, p.p. = *velutina* Meig.
Dipt. Suec. Phytomyzides, p. 7, p.p. (1823) (*Trineura*)

atra Meigen = *aterrima* Fabr.
Klass., vol. 1, p. 313. (1803) (*Trineura*)

montana Brues. U. S. A.; Peru.
Trans. Emer. Ent. Soc., vol. 29, p. 378, figs. (1904) (*Trineura*)
Beutenmuller, Bull. Amer. Mus. Nat. Hist., vol. 20, p. 99. (1904) (*Trineura*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 439. (1912)
Brues, Ann. Mus. Nat. Hungarici, vol. 3, p. 396. (1905) (*Trineura*)
nigra Schellenberg = ?*aterrima* Fabr.
Genr. Mouch. Dipt., p. 16, figs. (1803) (*Ceroplatus & Noda*)
nigerrima Macquart = *aterrima* Fabr.
Suit. à Buff., vol. 2, Plate 24. (1835)
obscura Zetterstedt = *aterrima* Fabr.
Dipt. Scand., vol. 7, p. 2884. (1848) (*Trineura*)
occidentata Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 438. (1912)
schineri Becker. Europe.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 80, fig. (1901) (*Trineura*)
Schiner, Faun. Austr., vol. 2, p. 347. (1864) (*Trineura stictica* Schiner, nec Meigen)
Malloch, Ann. Scottish Nat, Hist., p. 18. (1910) (*Trineura*)
stictica Meigen = *aterrima* Fabr.
Syst. Beschr., vol. 6, p. 225. (1830)
stictica Schiner = *schineri* Becker.
Faun. Austr., vol. 2, p. 347. (1864) (nec Meigen) (*Trineura*)
velutina Meigen. Europe; N. America.
Syst. Beschr., vol. 6, p. 224. (1830)
Macquart, Suit. à Buff., vol. 2, p. 630. (1835)
Van Roser, Wurttemb. Corrbl., 1840, p. 64. (1840)
Boitard, Nouv. Man. Entom., vol. 3, p. 522. (1843)
Zetterstedt, Dipt. Scand., vol. 7, p. 2892. (1848) (*Trineura*)
Walker, Ins., Brit., vol. 2, pl. 19, fig. 6. (1853)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 80, fig. (1901) (*Trineura*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 378, fig. (1903) (*Trineura*)
Malloch, Ann. Scottish Nat. Hist., p. 18. (1910) (*Trineura*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 439. (1912)

Melaloncha Brues

1903. Trans. Amer. Ent. Soc., vol. 29, p. 374.
1906. Brues, Genera Ins., fasc. 44, p. 8.
1912. Malloch, Proc. U. S. Nat. Mus., vo
1912. Enderlein, Stettiner Ent. Zeit., p. *Udamochiras*)
1912. Brues, Psyche, vol. 19, p. 136.

Type: *M. pulchel*

colossia Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 42. (*U*
Brues, Psyche, vol. 19, p. 136. (1912)

pulchella Brues. Bolivia, Paraguay.
Trans. Amer. Ent. Soc., vol. 29, p. 375. (1904)
Brues, Ann. Mus. Nat. Hungarici, vol. 9, p. 440, fig. (1911)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 500. (1912)
stylata Schiner. S. Am.
Novara Reise, Dipt., p. 224. (1868) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 375. (1903)

Apocephalus Coquillett

1901. Proc. Washington Acad. Sci., vol. 4, p. 501.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 372.
1906. Brues, Genera Ins., fasc. 44, p. 8.
1908. Brues, in Willistin's Man. N. Amer. Dipt., Ed. 3, p. 239.

Type: *A. pergandei* Coq.

aridus Malloch. Mexico.
Proc. U. S. Nat. Mus., vol. 43, p. 444, fig. (1912)
brasiliensis Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 24.
coquilletti Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 443, fig. (1912)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 373, fig. (1903) (*pergandei*)
curvinervis Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 26, fig. (1914)
pergandei Coq. U. S. A.
Proc. Entom. Soc. Washington, vol. 4, p. 501. (1901)
Fox, Proc. Ent. Soc. Washington, vol. 1, p. 100. (1887) (*sine nom.*)
Pergande, ibid., t.c., p. 497. (1901) (*sine descr.*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 443, fig. (1912)
Wheeler, Ants, their Structure, Develop. & Behavior, p. 419. (1910)
parvifurcatus Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 25.
similis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 444, fig. (1912)
spinicosta Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 442, fig. (1912)
wheeleri Brues. U. S. A.
Trans. Amer. Ent. Soc., vol. 29, p. 373, fig. (1904)
Malloch, Proc. U. S. Nat. M[illegible]s., vol. 43, p. 442, fig. (1912)

[illegible]ypocera Malloch

1912. Proc. U. S. [illegible]. 43, p. 439.

[illegible] *clypeata* Malloch

clypeata M[illegible]
Proc[illegible] 440, figs. (1912)

Beckerina Malloch

1910. Ann. Scottish Nat. Hist., p. 90.
1912. Proc. U. S. Nat. Mus., vol. 43, p. 441.

Type: *B. umbrimargo* Becker

orphnephiloides Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 441, figs. (1912)
umbrimargo Becker. Europe.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 65, fig. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 19, p. 168, 216. (1908) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 123. (1910) (*Aphiochaeta*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 441. (1912)

Neodohrniphora Malloch

Type: *N. calverti* Malloch

calverti Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 25. (1914)

Aphiochaeta Brues

1903. Trans. Amer. Ent. Soc., vol. 29, p. 337.
1906. Brues, Gen. Ins., fasc. 44, p. 9.
1908. Brues, in Williston's Man. N. Amer. Dipt., Ed. 3, p. 239.
1910. Malloch, Ann. Scottish Nat. Hist., p. 91.
1909. Malloch, Glasgow Natural, vol. 1, p. 28.

Type: *A. nigriceps* Lw.

aemula Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 549, fig. (1911)
aequalis Wood. England.
Entom. Monthly Mag., vol. 20, p. 25, 61. (1909) (*Phora*)
affinis Wood. England.
Entom. Monthly Mag., vol. 20, p. 25, 60. (1909) (*Phora*)
agarici Lintner. U. S. A.
10th Rept. State Entom. New York, p. 399. (1894) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 369, fig. (1903)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 499. (1912)
alajuelensis Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 32. (1914)
albicans Wood. England.
Entom. Monthly Mag., vol. 19, p. 172. (1908) (*Phora*)
Wood, ibid., vol. 23, p. 98. (1912) (*Phora*)
albicaudata Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 245, 247. (1910) (*Phora*)
albidohalteris Felt. U. S. A.
12th Rept. State Entom. New York, p. 228. (1896) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 368. (1903)

Wood, Entom. Month. Mag., vol. 20, p. 194, 243. (1909) (*Phora derasa*)
Popenoe, Circ. Bur. Ent. U. S. Dept. Agric., no. 155, p. 2, fig. (1912) (*albidihalteris*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 496. (1912)

albipennis Wood. England.
Entom. Monthly Mag., vol. 20, p. 116, 145. (1909) (*Phora*)

aletiae Comstock. U. S. A.
Rept. U. S. Dept. Agric. on Cotton Insects, p. 208. (1879) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 432. (1912)

alticolella Wood. England.
Entom. Monthly Mag., vol. 20, p. 114, 143. (1909) (*Phora*)

altifrons Wood. England.
Entom. Monthly Mag., vol. 20, p. 117, 146. (1909) (*Phora*)

angelicae Wood. England.
Entom. Monthly Mag., 2nd ser., vol. 21, p. 152, 199. (1910) (*Phora*)

angusta Wood. England.
Entom. Monthly Mag., vol. 20, p. 193, 243. (1909) (*Phora*)

angustifrons Wood. England.
Ent. Month. Mag., 2nd ser., vol. 23, p. 167. (1912) (*Phora*)

angustifurcata Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 31.

annulata Meigen. = *rufipes* Meig.
Klass., vol. 1, p. 314. (1804) (*Trineura*)

anomala Malloch. U. S. A. (N. H.)
Proc. U. S. Nat. Mus., vol. 43, p. 484. (1912)

apicalis Brues. India.
Ann. Mus. Nat. Hungarici, vol. 3, p. 544. (1905)

approximata Brunetti. India.
Rec. Indian Mus., vol. 7, p. 507. (1912)

approximata Malloch. = *secunda* Brues
Proc. U. S. Nat. Mus., vol. 43, p. 483. (1912) (non Brunetti)

arcuata Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 460. (1912)

arizonensis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 478. (1912)

armata Wood. England.
Entom. Monthly Mag., vol. 20, p. 24, 60. (1909) (*Phora*)

atlantica Brues. N. & S. America.
Trans. Amer. Entom. Soc., vol. 29, p. 362, fig. (1904)
Brues, Ann. Mus. Nat. Hungarici, vol. 3, p. 399. (1905)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 470. (1912) (*Phora*)

atomella Malloch. Alaska.
Proc. U. S. Nat. Mus., vol. 43, p. 481, fig. (1912)

atricapilla Curtis. = *fasciata* Fall.
Brit. Entom., p. 437. (1828) (*Phora*).

atriclava Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 545, fig. (1911)

atrimana Wood. England.
Ent. Month. Mag. 2nd ser., vol. 23, p. 166. (1912) (*Phora*)
atripes nom. nov. England.
Wood, Entom., Monthly Mag., vol. 20, p. 115 and 144. (1909) (*Phora nigripes* Wood, nec Strobl.)
aurea Aldrich. West Indies; S. America.
Trans. Ent. Soc. London, p. 437. (1896)
Coquillett, Proc. U. S. Nat. Mus., vol. 22, p. 253. (1900) (*Phora*)
Brues, Trans. Amer., Ent. Soc., vol. 29, p. 365, fig. (1903)
Beutenmuller, Bull. Amer. Mus. Nat. Hist., vol. 20, p. 99. (1904)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 467. (1912)
axillaris Zetterstedt. = *costalis* v. Ros.
Dipt. Scand., vol. 14, p. 6477. (1860) (*Trineura*)
banksi Brues. Philippines.
Journ. New York Entom. Soc., vol. 17, p. 5, fig. (1909)
barberi Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 450, fig. (1912)
barbulata Wood. England.
Entom. Monthly Mag., vol. 20, p. 115, 144. (1909) (*Phora*)
beckeri Wood. England.
Entom. Monthly Mag., vol. 20, p. 115, 144. (1909) (*Phora*)
bella Brues. Peru.
Ann. Mus. Nat. Hungarici, vol. 3, p. 398. (1905)
bezziana Enderlein. German East Africa.
Stettiner Ent. Zeit., 1912, p. 47.
bicolor Meigen. = *sulphuripes* Meig.
Syst. Beschr., vol. 6, p. 219. (1830) (*Phora*)
bicolor Macquart = *meigeni* Becker.
Suit. à Buff., vol. 2, p. 628. (1835) (*Phora*) (nec Miegen, 1830)
bicolorata Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 486. (1912)
biroi Brues. New Guinea.
Ann. Mus. Nat. Hungarici, vol. 5, p. 405, fig. (1907)
borealis Malloch. Canada.
Proc. U. S. Nat. Mus., vol. 43, p. 488. (1912)
brachyneura Egger = *pygmaea* Zett.
Verh. zool.-bot. Ges. Wien., vol. 12, p. 1236. (1862) (*Phora*)
braunsi Brues. Cape Colony.
Entom. News, vol. 18, p. 391. (1907)
Brues, Psyche, vol. 17, p. 36. (1910)
breviciliata Strobl = *giraudii* Egg.
Wien. Ent. Zeitg., vol. 18, p. 148. (1899) (*Phora*)
brevicostalis Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 243, 246. (1910) (*Phora*)
Wood, ibid., vol. 23, p. 171. (1912) (*Phora*)
brevis Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 113. (1912)

breviseta Wood. England.
Ent. Month. Mag., 2nd ser., vol. 23, p. 99. (1912)
brunneipennis Costa. Europe.
Giamb. Vico, vol. 2, p. 450. (1857) (*Megaselia*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 51, 73, 75. (1901) (*costalis*) (♀ non ♂)
Wood, Entom. Monthly Mag., vol. 23, p. 241. (1909) (*Phora*)
brunnipes Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 475. (1912)
californiensis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 447. (1912)
?camariana Coquerel. Madagascar.
Coquerel, Revue Zoologique, p. 186. (1848) (*Phora*)
Ann. Soc. Ent. France, vol. 6, p. 189. (1848) (*Phora*)
Bigot, Ann. Soc. Ent. France, sér. 3, vol. 3, p. 555. (1859) (*Phora*)
Laboulbène, Ann. Soc. Ent. France, sér. 5, vol. 5, bull., p. cxxxi. (1875) (*Phora*)
campestris Wood. England.
Entom. Monthly Mag., vol. 19, p. 174, 218. (1908)
carbonaria Zetterstedt = *ruficornis* Meig.
Dipt. Scand., vol. 7, p. 2865. (1848) (*Trineura*)
carlynensis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 468. (1912)
cata Melander & Brues. U. S. A.
Biological Bull., vol. 5, p. 16, fig. (1903)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 371. (1903)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 477. (1912)
catharinensis Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 40.
cavernicola Brues. U. S. A.
Bull. Wisconsin Nat. Hist. Soc., vol. 4, p. 101. (1906)
Hubbard, Amer. Ent., vol. 3, p. 34. (1880) (*sine nom.*)
Packard, Mem. Nat. Acad. Sci., vol. 5, p. 81. (1889) (*sine nom.*)
Aldrich, Rept. Indiana. St. Geol. for 1896, p. 190. (*Phora nigriceps*)
Bezzi, Atti. Soc. Ital. Sci. Nat., vol. 46, p. 11. (1907)
Bezzi, Arch. Zool. Expér. & Gen., vol. 48, p. 53. (1911)
cayuga Malloch. U. S. A.
Proc. U. S. A. Nat. Mus., vol. 43, p. 474. (1912)
chaetoneura Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 490. (1912)
chipensis Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 554, fig. (1911)
ciliata Zett. U. S. A.
Dipt. Scand., vol. 7, p. 2872. (1848) (*Trineura*)
Schiner, Fauna Austr., vol. 2, p. 341. (1864) (*Phora*)
Strobl, Programm Seitenst., vol. 14, p. 39. (1880) (*Phora*)
Neuhaus, Dipt. March., p. 342. (1886) (*Phora*)

Strobl, Wiener Ent. Zeitg., vol. 11, p. 200. (1892) (*Phora*)
Strobl, Mittheil. Naturwiss. Ver. Steiermark, vol. 30, p. 16. (1894) (*Phora*)
Strobl, Wien. Ent. Zeitg., vol. 18, p. 148. (1899) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 51, fig. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 20, p. 25, 61. (1909) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 123. (1910)
Malloch, Pros. U. S. Nat. Mus., vol. 43, p. 482. (1912)
Dahl, Faun. Chorin, p. 364 (26) & 389 (51) & 463 (125). (1912) (*Phora*)

cilipes Brues. New Guinea.
Ann. Mus. Nat. Hungarici, vol. 5, p. 406. (1907)

cilipes Wood. = *errata* Wood.
Entom. Monthly Mag., vol. 20, p. 120, 148. (1909) non Brues (*Phora*)

cinereifrons Strobl. Europe.
Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 124. (1910)

circumsetosa De Meijere. Java.
Tidj. Entom., vol. 54, p. 348. (1911)

clavipes Wood. England.
Ent. Monthly Mag., 2nd ser., vol. 21, p. 195, 201. (1910) (*Phora*)

coleopterorum Brischke = *pusilla* Meig.
Schrift. Naturf. Ges. Danzig, vol. 2, p. 4. (1868) (*Phora*)

collini Wood. England.
Entom. Monthly Mag., vol. 20, p. 28, 63. (1909) (*Phora*)

conformis Wood. England.
Entom. Monthly Mag., vol. 20, p. 113, 143. (1909) (*Phora*)

conglomerata Malloch. British Columbia.
Proc. U. S. Nat. Mus., vol. 43, p. 445. (1912)

conica Malloch. U. S. A. (D.C.)
Proc. U. S. Nat. Mus., vol. 43, p. 462, fig. (1912)

conjuncta Becker. Canary Is.
Mitth. Zool. Mus. Berlin, vol. 4, p. 93. (1908) (*Phora*)

conspicualis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 487. (1912)

consueta Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 113. (1912)

copalina Meunier. Zanzibar Copal.
Rev. Sci. Bourbonnais, 1905, p. 211, figs.

?**cornuta** Bigot. Cuba.
Sagra's Hist. fis. y nat. de Cuba, vol. 7, p. 348. (1856)

costalis v. Roser. Europe.
Württemb. Corrbl, 1840, p. 64. (*Phora*)
Rondani, Dipt. Ital. Prodr., vol. 1, p. 137. (1856) (*Megaselia crassineura*) (nom. nud.)
Zetterstedt, Dipt. Scand., vol. 14, p. 6474. (1860) (*Trineura costata*)
Zetterstedt, ibid., t.c., p. 6477. (1860) (*Trineura axillaris*)
Strobl, Wien. Ent. Zeitg., vol. 11, p. 194. (1892) (*Phora axillaris*)
Strobl, ibid., l.c. (1892) (*Phora crassicosta*)

Strobl, Mittheil. Naturwiss. Ver. Steiermark, vol. 30, p. 14. (1894) (*Phora axillaris*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 51, 73, 75, fig. (1901) (*Phora*) ♂ non ♀.
Strobl, ibid., l.c. (*Phora crassicosta*)
Wood, Entom. Monthly Mag., vol. 20, p. 192, 240. (1909) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 121. (1910)

costata Zetterstedt = *costalis* v. Ros.
Dipt. Scand., vol. 14, p. 6474. (1848) (*Trineura*)

crassicosta Strobl = *costalis* v. Ros.
Wien. Entom. Zeitg., vol. 11, p. 194. (*Phora*) (1892)

crassimana Brues. New South Wales.
Ann. Mus. Nat. Hungarici, vol. 3, p. 548. (1905)

crassineura Rondani = *costalis* v. Ros.
Dipt. Ital. Prodr., vol. 1, p. 137. (*Megaselia*) (nom. nud.)

crassipes Wood. England.
Entom. Monthly Mag., vol. 20, p. 24, 28. (1909) (*Phora*)

crinellicosta Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 38.

cubitalis Becker. = *humeralis* Zett.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 56, fig. (1901) (*Phora*)

curtifrons Brues, nom. nov. Formosa.
Brues, Ann. Mus. Nat. Hungarici, vol. 9, p. 548, fig. (1911) (*latifrons* Brues, non Wood)

curtineura Brues. Philippines.
Journ. New York Entom. Soc., vol. 17, p. 6, fig. (1909)

curva Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 552, fig. (1911)

dahli Becker. Europe.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 67, fig. (1901)

debilis Brues. New South Wales.
Ann. Mus. Nat. Hungarici, vol. 3, p. 549. (1905)

decipiens de Meijere. Java.
Ann. Jard. Bot. Buitenzorg 2nd sér., suppl. III, p. 934. (1910)

decipiens Wood. = *errata* Wood.
Entom. Monthly Mag., vol. 23, p. 169. (1912) non de Meijere. (*Phora*)

delicatula Brues. Peru.
Ann. Mus. Nat. Hungarici, vol. 3, p. 397. (1905)

denotata Wood. England.
Entom. Monthly Mag., vol. 20, p. 192, 242. (1909) ♀, non ♂ (*Phora*)
ibid., vol. 23, p. 170. (1912) ♂ (*Phora*)

derasa Wood. = *albidohalteris* Felt. England.
Entom. Monthly Mag., vol. 20, p. 194, 243. (1909) (*Phora*)

difficilis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 484. (1912)

discreta Wood. England.
Entom. Monthly Mag., vol. 20, p. 193, 242. (1909) (*Phora*)

divergens Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 480, fig. (1912)
diversa Wood. England.
Entom. Monthly Mag., vol. 20, p. 118, 146. (1909) (*Phora*)
dubitalis Wood. England.
Entom. Monthly Mag., vol. 19, p. 171. (1908) (*Phora*)
Wood, Entom. Monthly Mag., vol. 23, p. 98. (1912) (*Phora*)
dubitata Malloch. Canada.
Proc. U. S. Nat. Mus., vol. 43, p. 480. (1912)
dyari Malloch. Canada.
Proc. U. S. Nat. Mus., vol. 43, p. 493. (1912)
egena Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 110. (1912)
emarginata Wood. England.
Entom. Monthly Mag., vol. 19, p. 172. (1908) (*Phora*)
Wood, ibid., vol. 23, p. 98. (1912) (*Phora*)
enderleini Brues. Brazil.
Enderlein, Stettiner Ent. Zeit., p. 36. (1912) (*minuta* Enderlein, nec. Aldrich)
Brues, Psyche, vol. 19, p. 135. (1912)
erecta Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 196, 202. (1910) (*Phora*)
errata Wood. England.
Wood, Entom. Monthly Mag., vol. 20, p. 120, 148. (1909) (*cilipes* Wood, non Brues) (*Phora*)
Wood, ibid., vol. 23, p. 98. (1912) (*Phora*)
Wood, ibid., vol. 23, p. 169. (1912) (*decipiens* Wood, non de Meijere) (*Phora*)
ethiopia Meunier. Fossil; Zanzibar Copal.
Rev. Sci. Bourbonnais, 1905, p. 212, figs.
evarthae Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 472. (1912)
exaltata Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 34. (1914)
exigua Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 197, 202. (1910) (*Phora*)
exporrecta Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 80, figs. (1909)
extans Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 112, fig. (1912)
fasciata Fallen. Europe.
Dipt. Suec. Phytom., vol. 7, p. 9. (1823) (*Trineura*)
Curtis, Brit. Ent., p. 437. (1828) (*Phora atricapilla*)
Meigen, Syst. Beschr., vol. 6, p. 224. (1830) (*Phora*)
Curtis, Guide, sec. ed., p. 277. (1834) (*Phora*)
Westwood, Introd. Mod. Class. Ins., vol. 2, p. 575. (1840) (*Phora*)

Zetterstedt, Dipt. Scand., vol. 7, p. 2879. (1848) (*Trineura*)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1137. (1849) (*Phora*)
Ronandi, Atti. Soc. Ital. Sci. Nat., vol. 2, p. 165, fig. (1860) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 344. (1864) (*Phora*)
Perris, Ann. Soc. Ent. France, 1873, p. 74. (*Phora*)
Glover, Publ. MS. Notes from my Journ., p. 39. (1874) (*Phora atricapilla*)
Coquillett, Canadian Entom., vol. 27, p. 105. (1895) (*Phora*)
Aldrich, Trans. Ent. Soc. London, 1896, p. 436. (1896) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 50, fig. (1901) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 360. (1903)
Wood, Entom. Monthly Mag., vol. 21, p. 149, 197. (1910) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 448. (1912)

fasciventris Becker. Formosa.
Suppl. Entomologica, no. 3, p. 89, fig. (1914)

femoralis Enderlein. Brazil; Central Amer.
Stettiner Ent. Zeit., 1912, p. 30.
Malloch, Trans. Amer. Ent. Soc., vol. 40, p. 29. (1914)

fenestrata Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 517. (1912)

ferruginea Brunetti. India; Abyssinia.
Indian Mus. Notes, p. 84. (1912)
Austen, Trans. Soc. Trop. Med. & Hygiene, vol. 3, p. 229. (1910) (*sine desc.*)
Baker, Proc. Burma Branch British Med. Assoc., p. 11 and 28. (1891) (*sine nom.*)

ferruginea Enderlein = *ferruginosa* Brues.
Stettiner Ent. Zeit., p. 37. (1912)

ferruginosa Brues. Brazil.
Enderlein, Stettiner Ent. Zeit., p. 37. (1912) (*ferruginea* Enderl. nec Brunetti)
Brues, Psyche, vol. 19, p. 136. (1912)

fisheri Malloch.
Proc. U. S. Nat. Mus., vol. 43, p. 463. (1912)

fissa Becker. Madeira.
Mitth. Zool. Mus. Berlin, vol. 4, p. 193. (1908) (*Phora*)

flava Fall. Europe; N. Amer.; East Indies.
Dipt. Suec. Phytomyzides, p. 7. (1823) (*Trineura*)
Zetterstedt, Ins. Lapp., p. 797. (1838) (*Trineura*)
Boitard, Nouv. Man. Entom., vol. 3, p. 522. (1843) (*Phora*)
Zetterstedt, Dipt., Scand., vol. 7, p. 2876. (1848) (*Trineura*)
Walker, Ins. Brit., vol. 2, p. 280. (1853) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 343. (1864) (*Phora*)
Neuhaus, Dipt. March., p. 343. (1886) (*Phora*)
Strobl, Wien. Ent. Zeitg., vol. 11, p. 196. (1892) (*Phora*)
Strobl, Mitth. Naturwiss. Ver. Steiermark., vol. 30, p. 15. (1894) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 54, fig. (1901) (*Phora*)

Brues, Trans. Amer. Ent. Soc., vol. 29, p. 361, fig. (1903)
Brues, Ann. Mus. Nat. Hungarici, vol. 3, p. 551. (1905)
Wood, Entom. Monthly Mag., vol. 20, p. 28, 63. (1909) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 121. (1910)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 469. (1912)
Becker, Suppl. Entomologica, no. 3, p. 89. (1914)

flavescens Wood. England.
Entom. Monthly Mag., vol. 20, p. 26, 61. (1909) (*Phora*)

flavicauda Wood. England.
Entom. Monthly Mag., vol. 19, p. 253. (1908) (*Phora*)

flavifacies Brunetti. India.
Rec. Indian Mus., vol. 7, p. 509. (1912)

flaviclava Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 547. fig. (1911)

flavicoxa Zetterstedt = *ruficornis* Meig.
Dipt. Scand., vol. 7, p. 2869. (1848) (*Trineura*)

flavinervis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 493. (1912)

flavipalpis Malloch. U. S. A.
Psyche, vol. 20, p. 25. (1913)

flavohalterata Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 29.

flavopleura Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 31. (1914)

franconiensis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 479, figs. (1912)

frontalis Wood. England.
Entom. Monthly Mag., vol. 20, p. 119, 147. (1909) (*Phora*)

frontata Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 115. (1912)

fumata Malloch. England.
Entom. Monthly Mag., vol. 20, p. 35. (1909)

fumipennis Brues. New Guinea.
Ann. Mus. Nat. Hungarici, vol. 5, p. 407, fig. (1907)

fumipennis Enderlein = *umbripennis* Brues.
Stettiner Ent. Zeit., p. 37. (1912)

fungicola Coquillett. U. S. A.
Canad. Entom., vol. 27, p. 106. (1895)
Aldrich, Trans. Ent. Soc. London, p. 345. (1896) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 363, fig. (1903)
Coquillett, Proc. Washington Acad. Sci., vol. 2, p. 437. (1900) (*Phora*)
Coquillett, Harriman Alaska Exped., vol. 9, pt. 2, p. 51. (1904) (*Phora*)

fungivora Wood. England.
Entom. Monthly Mag., vol. 20, p. 116, 145, fig. (1909)
Wood, ibid., vol. 23, p. 169. (1912)

fungorum Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 473, fig. (1912)

furcella Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 32.
furtiva Aldrich. West Indies.
Trans. Ent. Soc. London, p. 436. (1896) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 367, fig. (1903)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 486. (1912)
fusca Wood. England.
Entom. Monthly Mag., vol. 20, p. 193, 242. (1909) (*Phora*)
fuscinervis Wood. England.
Entom. Monthly Mag., vol. 19, p. 173, 217, fig. (1908) (*Phora*)
fuscopedunculata Malloch. Canada.
Proc. U. S. Nat. Mus., vol. 43, p. 498. (1912)
giraudii Egger. Europe.
Verh. zool.-bot. Ges. Wien., vol. 12, p. 1235. (1862) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 341. (1864) (*Phora*)
Neuhaus, Dipt. March., p. 342. (1886) (*Phora*)
Slosson, Entom. News, vol. 6, p. 7. (1895) (*Phora*)
Strobl, Wiener Ent. Zeitg., vol. 11, p. 200. (1892) (*Phora*)
Strobl, Wiener Ent. Zeitg., vol. 18, p. 148. (1899) (*Phora*)
Strobl, ibid., l.c. (1899) (*Phora breviciliata* & *P. longiciliata*)
Strobl, Mitth. Naturwiss. Ver. Steiermark., vol. 30, p. 15. (1894) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 58. (1901) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 366. (1903)
Wood, Entom. Monthly Mag., vol. 19, p. 170 and 216. (1908) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 451. (1912)
glabrifrons Wood. England.
Entom. Monthly Mag., vol. 20, p. 27 and 62. (1909) (*Phora*)
grandicornis Strobl. Europe.
Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 123. (1910)
grandicornis Strobl, var. **pseudociliata** Strobl. Europe.
ibid., t.c., p. 124. (1910)
gregalis de Meijere. Java.
Ann. Jard. Bot. Buitenzorg, 2nd sér. suppl. III, p. 931. (1910)
gregaria Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 152, 199. (1910) (*Phora*)
?groenlandica Lundbeck. Greenland.
Vidensk. Medd. Naturh. Foren. Kjöbh., vol. 11, p. 307. (1900) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 350, fig. (1903) (*Phora*)
halictorum Melander & Brues. U. S. A.
Biological Bull. vol. 5, p. 14. (1903)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 366, fig. (1903)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 450. (1912)
halterata Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 196, 202. (1910) (*Phora*)
heracleëlae Bouché = *?sordida* Zett.
Naturg., p. 102. (1834) (*Phora*)

heracleëlae Strobl = *rufipes* Meig.
Wien. Entom. Zeitg., vol. 11, p. 202. (1892) (*Phora*) (nec Bouché)
hirsuta Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 246, 249. (1910) (*Phora*)
hirticaudata Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 246, 248. (1910) (*Phora*)
hirtiventris Wood. England.
Entom. Monthly Mag., vol. 20, p. 194, 243, fig. (1909) (*Phora*)
hortensis Wood. England.
Entom. Monthly Mag., vol. 20, p. 114, 143. (1909) (*Phora*)
humeralis Zetterstedt. Europe.
Ins. Lapp., p. 796. (1840) (*Trineura*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2862. (1848) (*Trineura*)
Strobl, Wiener Ent. Zeitg., vol. 11, p. 200. (1892) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien., vol. 1, p. 61. (1901) (*Phora*)
Becker, ibid., t.c., p. 56. (1901) (*Phora cubitalis*)
Wood, Entom. Monthly Mag., vol. 19, p. 171. (1908) (*Phora cubitalis*)
Wood, ibid., vol. 23, p. 98. (1912) (*Phora*)
Dahl, Faun. Chorin, p. 364 (26) & 464 (126). (1912) (*Phora*)
humilis Wood. England.
Entom. Monthly Mag., vol. 20, p. 114, 143. (1909) (*Phora*)
hyalipennis Wood. England.
Ent. Month. Mag., 2nd ser., vol. 23, p. 168. (1912) (*Phora*)
inaequalis Brunetti. India.
Rec. Indian Mus., vol. 7, p. 511. (1912)
inaequalis Malloch. = *tertia* Brues
Proc. U. S. Nat. Mus., vol. 43, p. 464. (1912)
incisa Malloch. Mexico.
Proc. U. S. Nat. Mus., vol. 43, p. 470. (1912)
inflata Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geolog. Landesanst., vol. 30, p. 79, fig. (1909)
infraposita Wood. England.
Entom. Monthly Mag., vol. 20, p. 119, 147. (1909) ♂ (*Phora*)
Wood, ibid., vol. 23, p. 169. (1912) ♀ (*Phora*)
infumata Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 490, fig. (1912)
innocens Collin. Seyshelles.
Trans. Linn. Soc. London, vol. 15, p. 112, fig. (1912)
inornata Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 488. (1912)
insolita Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 81, fig. (1909)
insulana Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 542, fig. (1911)
interrupta Zetterstedt = *picta* Lehm.
Ins. Lapp., p. 797. (1838) (*Trineura*)

invenusta Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 115. (1912)
involuta Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 153, 200. (1910) (*Phora*)
iroquoiana Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 476. (1912)
johannseni Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 474. (1912)
juli Brues. U. S. A.
Journ. New York Entom. Soc., vol. 16, p. 201. (1908) (*Plastophora*)
Lintner Canadian Entom., vol. 16, p. 80. (1884) (*sine nom.*)
Dimmock, ibid., t.c., p. 100. (1884) (*sine nom.*)
Banks, Trans. Washington Ent. Soc., vol. 13, p. 212, fig. (1911) (*xantippe*)
Brues, Psyche, vol. 19, p. 136. (1912)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 459. (1912)
Knab, Insecutor Inscitiae Menstruus, vol. 1, p. 24. (1913)
kerteszi Enderlein. Costa Rica.
Stettiner Ent. Zeit., 1912, p. 48.
lata Wood. England.
Ent. Monthly Mag., 2nd ser., vol. 21, p. 151, 199. (1910)
latifasciata Brunetti. India.
Rec. Indian Mus., vol. 7, p. 508. (1912)
latifemorata Becker. Europe.
Abh. zool-bot. Ges. Wien, vol. 1, p. 67, fig. (1901) (*Phora*)
latifrons Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 151, 198. (1910)
latifrons Brues. = *curtifrons*, n. nov. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 548, fig. (1911)
latimanus Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 31. (1914)
latinervis Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 116, fig. (1912)
lauta Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 81, figs. (1909)
ledburiensis Wood. England.
Ent. Monthly Mag., 2nd ser., vol. 21, p. 197, 202. (1910) (*Phora minutissima* Wood, non Brues)
limbata Brues. India; Seychelles.
Ann. Mus. Nat. Hungarici, vol. 3, p. 546. (1905)
litoralis Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 39. (1914) (*littoralis*)
Collin, Trans. Linn. Soc. London, vol. 15, p. 110, fig. (1912)
longiciliata Strobl. = *giraudii* Egger.
Wien. Ent. Zeitg., vol. 18, p. 148. (1899) (*Phora*)
longicostalis Wood. England.
Ent. Month. Mag., 2nd ser., vol. 23, p. 171. (1912)

longipalpis Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 152, 199. (1910) (*Phora*)
longipennis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 473, fig. (1912)
longiseta Wood. England.
Entom. Monthly Mag., vol. 20, p. 26, 61. (1909) (*Phora*)
luctuosa Strobl = *pulicaria* Fall.
Wien. Ent. Zeitg., vol. 11, p. 202. (1892) (*Phora*)
luederwaldti Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 39.
lutea Meigen = *sulphuripes* Meig.
Syst. Beschr., vol. 6, p. 220. (1830) (*Phora*)
lutea Schiner = *melanocephala* v. Ros.
Faun. Austr., vol. 2, p. 343. (1863) (*Phora*)
lutescens Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 244, 247. (1910) (*Phora*)
Wood, ibid., vol. 23, p. 171. (1912) (*Phora*)
macrochaeta Malloch. Porto Rico.
Proc. U. S. Nat. Mus., vol. 43, p. 464. (1912)
magnipalpis Aldrich. West Indies.
Trans. Ent. Soc. London, p. 438. (1896) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 365, fig. (1903)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 446. (1912)
mallochi Wood. England.
Entom. Monthly Mag., vol. 20, p. 27, 62. (1909) (*Phora*)
Wood, ibid., vol. 23, p. 167. (1912) (*Phora*)
manca Brues. Singapore.
Ann. Mus. Nat. Hungarici, vol. 5, p. 408, fig. (1907)
manicata Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 246, 248. (1910) (*Phora*)
marginalis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 457. (1912)
maura Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 196, 201. (1910) (*Phora*)
media Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 116. (1912)
meigeni Becker. Europe.
Macquart, Suit. à Buff., vol. 2, p. 628. (1835) (*Phora bicolor*, nec Meigen)
Zetterstedt, Dipt. Scand., vol. 7, p. 2880. (1848) (*Trineura bicolor*, nec Meigen)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1137. (1849) (*Phora bicolor*)
Zetterstedt, ibid., vol. 14, p. 6478. (1860) (*Trineura bicolor*, nec Meigen)
Schiner, Faun. Austr., vol. 2, p. 337. (1864) (*Phora bicolor*)
Strobl, Wiener, Ent. Zeitg., vol. 11, p. 196. (1892) (*Phora bicolor*)

Strobl, Mitth. Naturwiss. Ver. Steiermark, vol. 30, p. 15. (1894) (*Phora bicolor*, nec Meigen)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 53. (1901) (*Phora*)
Becker, Zeitschr. f. Syst. Hym. & Dipt., vol. 7, p. 256. (1907) (*Phora*)
Wood, Entom. Monthly Mag., vol. 19, p. 169, 216. (1908) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 121. (1910)

melanocephala v. Roser. Europe.
Wurttemb. Correspondenzbl., p. 64. (1840) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 343. (1864) (*Phora lutea*, nec Meigen)
Neuhaus, Dipt. March., p. 343. (1886) (*Phora lutea* Schiner, nec Meigen)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 55, fig. (1901) (*Phora*)
Strobl, Wien. Ent. Zeitg., vol. 11, p. 196. (1892) (*Phora lutea* Schiner, nec Meigen)
Strobl, Mitth. Naturwiss. Ver. Steiermark, vol. 30, p. 15. (1894) (*lutea*)

meracula Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 555, fig. (1911)

meridionalis Brues. Paraguay.
Ann. Mus. Nat. Hungarici, vol. 5, p. 402, fig. (1907)

minor Zetterstedt. Europe; N. America.
Dipt. Scand., vol 7, p. 2864. (1848) (*Trineura*)
Zetterstedt, ibid., vol. 12, p. 4824. (1855) (*Trineura*)
Aldrich, Canadian Entom., vol. 24, p. 146. (1892) (*Phora minuta*)
Strobl, Wien., Ent. Zeitg., vol. 11, p. 200. (1892) (*Phora nitidifrons*)
Strobl, Mittheil. Naturwiss, Ver. Steiermark, vol. 30, p. 16. (1894) (*Phora nitidifrons*)
Coquillett, Canadian Entom., vol. 27, p. 105. (1895) (*Phora minuta*)
Strobl, ibid., vol. 18, p. 148. (1899) (*Phora nitidifrons*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 63 and 73. (1901) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 366. (1903) (*minuta*)
Wood, Entom. Monthly Mag., vol. 20, p. 28, 62. (1909) (*Phora*)
Strobl. Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 122. (1910) (*nitidifrons*)
Wood, Entom. Monthly Mag., vol. 23, p. 167. (1912) (*Phora*)
Dahl, Faun. Chorin, p. 355 (17) & 463 (125). (1912) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 494, (1912)

minuta Aldrich = *minor* Zett.
Canadian Entom., vol. 26, p. 146. (1892) (*Phora*)

minuta Enderlein = *enderleini* Brues.
Stettiner Ent. Zeitg., p. 23. (1912)

minutissima Brues. New Guinea.
Ann. Mus. Nat. Hungarici, vol. 3, p. 549. (1905)

minutissima Wood.
See *A. ledburiensis*.

monticola Malloch. Canada.
Proc. U. S. Nat. Mus., vol. 43, p. 479. (1912)

mana Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 551. (1911)
necrophoga Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 49.
nedae Malloch. Mexico.
Proc. U. S. Nat. Mus., vol. 43, p. 448. (1912)
nigra Meigen = *pusilla* Meig.
Syst. Beschr., vol. 6, p. 218. (1830) (*Phora*) (nec Schellenberg)
nigra Strobl = *pulicaria* Fall.
Programm Seitsenst., vol. 14, p. 39. (1880) (*Phora*) (non Meigen, nec Schellenberg)
nigrescens Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 244, 249. (1910) (*Phora*)
Wood, ibid., vol. 23, p. 171. (1912) (*Phora*)
nigriceps Lw. U. S. A. (Eastern).
Cent. 7, p. 53. (1866) (*Phora*)
Aldrich, Canad. Entom., vol. 24, p. 143. (1892) (*Phora*)
Coquillett, Canad. Ent., vol. 27, p. 105. (1895) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 363, fig. (1903)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 460, (1912)
nigripes Strobl = *pulicaria* Fall.
Wien. Ent. Zeitg., vol. 11, p. 202. (1892) (*Phora*)
nigripes Wood. = *atripes* nom. nov.
Entom. Monthly Mag., vol. 20, p. 115, 144. (1909)
nigrocincta De Meijere. Holland.
Tijd. Entom., vol. 50, p. 189. (1907)
nitidifrons Strobl = *minor* Zett.
Wien. Ent. Zeitg., vol. 11, p. 200. (1892) (*Phora*)
nudipes Becker. Europe.
Abh. zool.-bot. Ges, Wien, vol. 1, p. 66. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 19, p. 173, 217. (1908) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 123. (1910)
nudiventris Wood. England.
Entom. Monthly Mag., vol. 20, p. 195, 244. (1909) (*Phora*)
obscura Brues. West Indies.
Trans. Amer. Ent. Soc., vol. 29, p. 360, fig. (1904)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 471. (1912)
obscurata Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 35.
obscuripennis Wood. England.
Entom. Monthly Mag., vol. 20, p. 113, 143. (1909) (*Phora*)
ochracea Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 543, fig. (1911)
orientalis Schiner.
Dipt. Novara Reise, p. 224. (1868) (*Phora*)
orientata Malloch. Java.
Proc. U. S. Nat. Mus., vol. 43, p. 513, fig. (1912)

pallens Wood. England.
Ent. Month, Mag., 2nd ser., vol. 21, p. 150, 198. (1910) (*Phora*)
pallicornis Brunetti. India.
Rec. Indian Mus., vol. 7, p. 511. (1912)
pallipes Latreille = *rufipes* Meigen.
Gen. Crust. Ins., vol. 4, p. 360. (1809) (*Phora*)
palmeni Becker. Europe.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 65. (1901) (*Phora*)
palpatrix Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 35.
paludosa Wood. England.
Entom. Monthly Mag., vol. 19, p. 174, 217. (1908) ♂ (*Phora*)
Wood, ibid., vol. 23, p. 99. (1912) ♀ (*Phora*)
parva Wood. England.
Entom. Monthly Mag., vol. 20, p. 27, 62. (1909) (*Phora*)
pauxilla Brues. Argentina.
Ann. Mus. Nat. Hungarici, vol. 5, p. 402, fig. (1907)
pectoralis Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 153, 200. (1910) (*Phora*)
perdita Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 459. (1912)
peregrina Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 492. (1912)
perplexa Malloch. Canada.
Proc. U. S. Nat. Mus., vol. 43, p. 489. (1912)
peruviana Brues. Peru.
Ann. Mus. Nat. Hungarici, vol. 3, p. 396. (1905)
picta Lehmann. Europe; N. Amer.
Indic. schol. Hamburg, p. 43, fig. (1822) (*Phora*)
Lehmann, Acta Acad. Leop. Carol., vol. 12, p. 245. (1824) (*Phora*)
Zetterstedt, Ins. Lapp., p. 797. (1838) (*Trineura interrupta*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2878. (1848) (*Trineura interrupta*)
Zetterstedt, ibid., vol. 14, p. 6478. (1860) (*Trineura interrupta*)
Schiner, Faun. Austr., vol. 2, p. 337. (1864) (*Phora interrupta*)
Coquillett, Canad. Entom., vol. 27, p. 104. (1895) (*Phora interrupta*)
Mik, Wien. Ent. Zeitg., vol. 15, p. 112. (1896) (*Phora*)
Aldrich, Trans. Ent. Soc. London, p. 435. (1896) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 52, fig. (1901) (*Phora*)
Brues, Trans. Amer. Ant. Soc., vol. 29, p. 361, fig. (1903)
Wood, Entom. Monthly Mag., vol. 19, p. 169 and 216. (1908) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 121. (1910)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 451, fig. (1912)
pilosa Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 33. (1914)
planifrons Brues. New Guinea.
Ann. Mus. Nat. Hungarici, vol. 3, p. 547. (1905)

planipes Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 114, fig. (1912)
pleuralis Wood. England.
Entom. Monthly Mag., vol. 20, p. 117, 146. (1909) (*Phora*)
Dahl. Faun, Chorin, p. 377 (38) & 463 (125). (1912) (*Phora*)
polita Enderlein. Brazil; Central Amer.
Stettiner Ent. Zeit., 1912, p. 30.
Malloch, Trans. Amer. Ent. Soc., vol. 40, p. 29. (1914)
posticata Strobl. Europe.
Glasnik Zem. Mus. Bosn. Herceg., vol. 10, p. 591. (1898) (*Phora*)
Strobl, Wiss. Mittheil, Bosn. Herceg., vol. 7, p. 646. (1900) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 125. (1910)
proboscidea Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 477, fig. (1912)
projecta Becker. Europe.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 56. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 19, p. 170. (1908) (*Phora*)
Wood, Ent. Month. Mag., vol. 23, p. 97, fig. (1912) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 446. (1912)
propinqua Wood. England.
Entom. Monthly Mag., vol. 20, p. 27, 62. (1909) (*Phora*)
prosthioxantha Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 39.
pruinosa Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 30. (1914)
pulicaria Fallen. Europe; Asia; N. Amer.; Australia.
Dipt. Suec. Phytom., p. 7. (1823) (*Trineura*)
Meigen, Syst. Beschr., vol. 6, p. 217. (1830) (*Phora*)
Macquart, Suit. à Buff., vol. 2, p. 628. (1835) (*Phora*)
Zetterstedt, Ins. Lapp., p. 795. (1838) (*Trineura*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2859. (1848) (*Trineura*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2873. (1848) (*Trineura pumila*)
Scholtz, Entom. Zeits. Breslau, vol. 4, p. 28. (1848) (*Phora*)
Macquart, Explor. Scient. Algérie, Zool., vol. 3, p. 502. (1849) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 341. (1864) (*Phora*)
Wulp, Tijdschr. Entom., vol. 6, p. 210. (1871) (*Phora*)
Ritzema, Ann. Soc. Entom. Neer., vol. 6, p. 210. (1871) (*Phora*)
Ritsema, Petit. Nouvell. Entomol., vol. 6, p. 367. (1874) (*Phora*)
Strobl, Programm Seitenst., vol. 14, p. 39. (1880) (*Phora nigra*, nec Meigen)
Neuhaus, Dipt. March., p. 342. (1886) (*Phora*)
Strobl, Wien. Ent. Zeitg., vol. 11, p. 202. (1892) (*Phora*)
Strobl, ibid., l.c. (1892) (*luctuosa*, nec Meigen; *nigra*, nec Meigen; *nigripes; pumila* Zett., nec Meigen)
Strobl, Mitth. Naturwiss. Ver. Steiermark, vol. 30, p. 16. (1894) (as above)
Wasmann, Krit. Verzeichen., p. 174. (1894) (*Phora*)

Strobl, Wien. Entom. Zeitg., vol. 18, p. 148. (1899) (as above)
Strobl, Wiss. Mittheil. Bosn. Herceg., vol. 7, p. 646. (1900) (*Phora luctuosa*, nec Meigen)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 62. (1901) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 371, fig. (1903)
Past, Casopis Ceské Spol. Entom., vol. 2, p. 110, fig. (1905)
Brues, Ann. Mus. Nat. Hungarici, vol. 3, p. 551. (1905)
Strobl, Mem. R. Soc. Espan. Hist. Nat., vol. 3, p. 335. (1906) (*Phora*) (also as *luctuosa, nigra, pumila*)
Wood, Entom. Monthly Mag., vol. 20, p. 195 and 243. (1909) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 122. (1910)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 495. (1912)
Dahl, Faun. Chorin, p. 364 (26) & 402 (64) & 462 (124). (1912) (*Phora*)
Becker, Suppl. Entomologica, no. 3, p. 90. (1914)

pumila Meigen. = *pusilla* Meigen.
Syst. Beschr., vol. 6, p. 218 (20). (1830) (*Phora*)

punctifemur Enderlein. Brazil.
Stettiner. Ent. Zeit., 1912, p. 33.

punctifemur, var. **fasciiventris** Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 33.

punctifemur, var. **fuscivertex** Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 34.

punctifemur, var. **immaculipes** Enderlein.
Stettiner Ent. Zeit., 1912, p. 34.

pusilla Meigen. Europe; Australia.
Meigen, Syst. Beschr., vol. 6, p. 218 (19). (1830) (*Phora*)
Meigen, ibid., t.c., p. 218. (1830) (*Phora nigra*, nec Schellenb.)
Meigen, ibid., t.c. (1830) (*Phora pumila*)
Macquart, Suit. à Buff., vol. 2, p. 628. (1835) (*Phora nigra* Meig.; *Phora*)
Dufour, Soc. Sci. Lille, 1841, p. 418, fig. (*Phora nigra*)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1136. (1849) (*Phora nigra*)
Walker, Ins. Brit., vol. 2, p. 281. (1853) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 345. (1864) (*Phora nigra; Phora pumila*)
Brischke, Schrift. Naturf. Danzig, vol. 2, p. 4. (1868) (*Phora coleopterorum*)
Perris, Ann. Soc. Entom. France, vol. 10, p. 354, fig. (1870) (*Phora*)
Strobl, Programm. Seitenst., p. 39. (1880) (*Phora nigra*)
Strobl, Wien. Ent. Zeitg., vol. 11, p. 203. (1892) (*Phora*)
Neuhaus, Dipt. March., p. 344. (1886) (*Phora nigra; Phora pumila*)
Strobl, Mitth. Naturwiss. Ver. Steiermark, vol. 30, p. 16. (1894) (*Phora*)
Dahl, SB., Naturf. Fr. Berlin, p. 197, fig. (1898) (*Phora pumila*)
Strobl, Wiener Ent. Zeitg., vol. 18, p. 148. (1899) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 63, fig. (1901) (*Phora*)
Speiser, Allg. Zeits. Entom., vol. 9, p. 266. (1904) (*Phora coleopterorum*)

Brues, Ann. Mus. Nat. Hungarici, vol. 3, p. 551. (1905)
Strobl, Mem. R. Soc. Espan. Hist. Nat., vol. 3, p. 335. (1906) (*Phora*)
Becker, Zeits. Syst. Hym. & Dipt., vol. 7, p. 256. (1907) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 120. (1910)
Dahl, Faun. Chorin, p. 355 (17) & 463 (125). (1912) (*Phora*)
Bezzi, Arch. Zool. Expér. & Gén., vol. 48, p. 15 and 53. (1911) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 413. (1912) (*nigra*)

pumila Zetterstedt = *pulicaria* Fall.
Dipt. Scand., vol. 7, p. 2873. (1848) (*Trineura*) (nec Meigen)

pygmaea Zetterstedt. Europe; N. Amer.; Formosa.
Dipt. Scand., vol. 7, p. 2860. (1848) (*Trineura*)
Egger, Verh. zool.-bot. Ges. Wien, vol. 12, p. 1236. (1862) (*Phora brachyneura*)
Schiner, Faun. Austr., vol. 2, p. 344. (1864) (*Phora brachyneura*)
Strobl, Wien. Ent. Zeitg., vol. 11, p. 196. (1892) (*Phora brachyneura*)
?Strobl, Ibid., t.c., p. 204. (1892) (*Phora*)
Strobl, Mitth. Naturwiss. Ver. Steiermark, vol. 30, p. 15. (1894) (*Phora brachyneura*)
Strobl, Wien, Ent. Zeitg., vol. 18, p. 148. (1899) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 49, fig. (1901) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 359. (1903)
Strobl. Mem. R. Soc. Espan. Hist. Nat., vol. 3, p. 335. (1906) (*Phora*)
Strobl, ibid., t.c., p. 336. (1906) (*Phora brachyneura*)
Bezzi, Bull. Soc. Ent. Ital., vol. 39, p. 36. (1908)
Wood, Entom. Month. Mag., vol. 21, p. 151, 199. (1910)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 120. (1910)
Brues, Ann. Nat. Mus. Hungarici, vol. 9, p. 542, fig. (1911)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 499. (1912)
Dahl, Faun. Chorin, p. 364 (26) & 463 (125). (1912) (*Phora*)

rata Collin. England.
Entom. Monthly Mag., vol. 19, p. 172. (1908) (*Phora*)
Wood, ibid., vol. 23, p. 98. (1912)

recta Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 553. (1911)

rectangulata Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 33. (1914)

retardata Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 482. (1912)

retroversa Wood. England.
Entom. Monthly Mag., vol. 19, p. 173, 217, fig. (1908) (*Phora*)

rivalis Wood. England.
Entom. Monthly Mag., vol. 20, p. 26, 61. (1909) (*Phora*)

rostrata Melander & Brues. U. S. A.
Biological Bull., vol. 5, p. 15. (1903)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 370, fig. (1903)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 477. (1912)

rubescens Wood. England.
Ent. Month. Mag., vol. 23, p. 170, fig. (1912) (*Phora*)
rudis Wood. England.
Entom. Monthly Mag., vol. 20, p. 25, 60. (1909) (*Phora*)
rufa Wood. England.
Entom. Monthly Mag., vol. 19, p. 170. (1908) (*Phora*)
Wood, ibid., vol. 23, p. 97. (1912) (*Phora*)
ruficornis Meigen. Europe; N. Am.
Syst. Beschr., vol. 6, p. 218. (1830) (*Phora*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2863. (1848) (*Trineura*)
Zetterstedt, ibid., t.c., p. 2865. (1848) (*Trineura carbonaria*)
Zetterstedt, ibid., t.c., p. 2869. (1848) (*Trineura flavicoxa*)
Zetterstedt, ibid., vol. 11, p. 4340. (1852) (*Trineura flavicoxa*)
Zetterstedt, ibid., vol. 14, p. 6476. (1860) (*Trineura flavicoxa*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 57 and 70. (1901) (*Phora*)
Becker, ibid., t.c., p. 74. (1901) (*Phora carbonaria*)
Wingate, Entom. Monthly Mag., vol. 17, p. 110. (1906) (*Phora*)
Wood, Entom. Monthly Mag., vol. 19, p. 171. (1908) (*Phora*)
Strobl, Mitt. Naturwiss. Ver Steiermark, vol. 46, p. 121. (1910)
Wood, ibid., vol. 23, p. 98. (1912) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 466. (1912)
rufifrons Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 153, 200. (1910) (*Phora*)
rufipes Meigen. Europe; North America.
Klass., vol. 1, p. 313, fig. (1804) (*Trineura*)
Meigen, ibid., t.c., p. 314. (1804) (*Trineura annulata*)
Fabricius, Syst. Antl., p. 336. (1805) (*Trineura*)
Latreille, Genr. Crust. Ins., vol. 14, p. 395. (1809) (*Phora pallipes*)
Fallen, Dipt. Suec. Phytom., p. 6. (1823) (*Trineura vulgaris* p.p.)
St. Fargeau & Serville, Encycl. Méthod., vol. 10, p. 112. (1825) (*Phora*)
Boitard, Man. Entom., vol. 2, p. 397. (1828) (*Phora pallipes*)
Meigen, Syst. Beschr., vol. 6, p. 216. (1830) (*Phora annulata*)
Meigen, ibid., t.c., p. 216. (1830) (*Phora*)
Macquart, Suit. à Buff., vol. 2, p. 627. (1835) (*Phora annulata*)
Macquart, ibid., l.c. (1835) (*Phora*)
Zetterstedt, Ins. Lapp., p. 795. (1838) (*Trineura*)
Dufour, Ann. Sci. Nat., vol. (2) 12, p. 54, figs. (1840) (*Phora pallipes*)
Dufour, ibid., vol. (2) 13, p. 161. (1840) (*Phora*)
Boitard, Nouv. Man. Entom., vol. 3, p. 522. (1843) (*Phora*)
Ratzeburg, Forstins., vol. 3, p. 175. (1844) (*Phora*)
Bremi, Isis, 1847, p. 173. (*Phora annulata*)
Bouché, Stettin. Ent. Zeitg., vol. 8, p. 146. (1847) (*Phora*)
Gimmerthal, Arb. nat. Ver. Riga, vol. 1, p. 324, fig. (1848) (*Phora annulata*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2857. (1848) (*Trineura*)
Zetterstedt, ibid., vol. 8, p. 3365. (1849) (*Trineura*)

Walker, List. Dipt. Brit. Mus., vol. 4, p. 1136. (1849) (*Phora*) (also *P. annulata*)
Dufour, Mém. Acad. Sci. Math. Phys., vol. 11, p. 171, fig. (1850) (*Phora pallipes*)
Zetterstedt, Dipt. Scand., vol. 12, p. 4823. (1852) (*Trineura*)
Walker, Ins. Brit., vol. 2, p. 280, fig. (1853) (*Phora*)
Heeger, SB. Acad. Wien, vol. 10, p. 173. (1853) (*Phora*)
Heeger, ibid., t.c., p. 174. (1853) (*Phora annulata*)
Dufour, Ann. Soc. Ent. France, vol. 1, p. 385. (1853) (*Phora pallipes*)
Schiner, Faun. Austr., vol. 2, p. 340. (1864) (*Phora*)
Laboulbène, Ann. Soc. Ent. France, vol. 4, p. 69. (1864) (*Phora*)
Laboulbène, ibid., t.c., p. 88. (1864) (*Phora pallipes*)
Glover, Publ. MS. Notes from my Journ, p. 40. (1874) (*Phora*)
Schnabl, Deutsch. Ent. Zeits., vol. 20, p. 217, fig. (1876) (*Phora*)
Brandt, Hor. Soc. Entom. Ross., vol. 15, pl. 1, fig. 12. (1879) (*Phora*)
Strobl, Programm Seitenst., p. 39. (1880) (*Phora*)
Waterhouse, Trans. Ent. Soc. London, 1881, p. xxxvii. (1881) (*Phora*)
Meade, The Entomologist, vol. 15, p. 285. (1881) (*Phora*)
Schnabel, Wiad. 3. nauk. przyr., vol. 2, p. 1. (1882) (*Phora*)
Becher, Denkschr. Akad. Wien, vol. 45, p. 151, fig. (1882) (*Phora*)
Girschner, Entom. Nachr., vol. 9, p. 204. (1883) (*Phora*)
Brauer, Denkschr. Akad. Wien, vol. 47, p. 66. (1883) (*Phora*)
Neuhaus, Dipt. March., p. 342. (1886) (*Phora*)
Mayer, Soc. Entom., vol. 1, p. 146. (1887) (*Phora*)
Strobl, Wien, Ent. Zeitg., vol. 11, p. 202. (1892) (*Phora*)
Strobl, ibid., l.c. (1892) (*Phora heracleelae*, nec Bouché)
Strobl. Mittheil. Naturwiss. Ver. Steiermark, vol. 30, p. 16. (1893) (*Phora*)
Wasmann, Krit. Verzeichn., p. 174. (1894) (*Phora*) (also *P. heracleelae*)
Coquillett, Canadian Entom., vol. 27, p. 105. (1895) (*Phora*)
Coquillett, Amer. Naturalist, vol. 31, p. 386. (1897) (*Phora*)
Kieffer. Ill. Zeits. f. Entom., vol. 5, p. 241. (1900) (*Phora*)
Coquillett, Proc. Washington Acad. Sci., vol. 2, p. 437. (1900) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 59. (1901) (*Phora*)
Meijere, Zool. Jahrb. Abth. f. Syst., vol. 15, p. 677, fig. (1901) (*Phora*)
Xambeu, Ann. Soc. Linn. Lyon, vol. 48, p. 39. (1902) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 368, fig. (1903)
Strobl, Dipterenfaun. Balkanhalbinsel, p. 571. (1904) (*Phora*)
Coquillett, Harriman Alaska Exped., vol. 9, pt. 2, p. 51. (1904) (*Phora*)
Strobl, Mem. R. Soc. Espan. Hist. Nat., vol. 3, p. 334. (1906) (*Phora*)
Ghidini, Boll. Soc. Tic. Sci. Nat., vol. 3, p. 23. (1907) (*Phora*)
Schmitz, Tijdschr. Entom., vol. 52, p. 80. (1909) (*Phora*)
Wood, Entom. Monthly Mag., vol. 20, p. 194 and 243. (1909) (*Phora*)
Walden, Rept. State Entom. Connecticut, for 1910, p. 693, fig. (1910)
Bezzi, Arch. Zool. Expér. & Gén., vol. 48, p. 60. (1911)
Keilin, Bull. Sci. France & Belgique, vol. 44, p. 61, fig. (1911) (*Phora*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 494. (1912)

rustica Brues. New Guinea.
Ann. Mus. Nat. Hungarici, vol. 3, p. 546. (1905)
rusticata Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 489. (1912)
sauteri Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 556, fig. (1911)
scalaris Lw. N. Amer.
Cent. 7, p. 53. (1866)
Coquillett, Canadian Entom., vol. 27, p. 105. (1895) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 364, fig. (1903)
Malloch, Proc. U. S. Nat. Mus., vol. 45, p. 467. (1912)
scalaris, var. cordobensis Malloch. Mexico.
Proc. U. S. Nat. Mus., vol. 43, p. 467, fig. (1912)
schwarzi Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 517. (1912)
scutellaris Wood. England.
Entom. Monthly Mag., vol. 20, p. 120, 148, fig. (1909) *Phora*
secunda nom. nov. U. S. A.
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 483. (1912) (*approximata* Malloch, non Brunetti.)
sepulta Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 80, fig. (1909)
serrata Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 150, 198. (1910) (*Phora*)
setacea Aldrich. U. S. A.
Canadian Entom., vol. 24, p. 144. (1892) (*Phora*)
Coquillett, Canadian Entom., vol. 27, p. 105. (1895) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 370, fig. (1903)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 495, fig. (1912)
setaria Malloch. Hawaii.
Proc. U. S. Nat. Mus., vol. 43, p. 514. (1912)
seticauda Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 32. (1914)
setimargo Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 32.
sexspinosa Collins. = *flavicoxa* Zett.
Entom. Monthly Mag., vol. 19, p. 169. (1908) (*Phora*)
ibid., p. 254. (*Phora*)
simplex Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 154, 201. (1910) (*Phora*)
simulans Wood. England.
Ent. Month. Mag., 2nd ser., vol. 23, p. 97, fig. (1912) (*Phora*)
smithii Brues. U. S. A.
Bull. Wisconsin Nat. Hist. Soc., vol. 7, p. 106. (1909)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 497. (1912)
sodalis Brues. New South Wales.
Ann. Mus. Nat. Hungarici, vol. 3, p. 550. (1905)

soluta Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 117, fig. (1912)
sordida Zett. Europe.
Ins. Lapp., p. 796. (1840) (*Trineura*)
?Bouché, Naturg., p. 102. (1834) (*Phora heracleelae*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2861. (1848) (*Trineura*)
?Schiner, Faun. Austr., vol. 2, p. 341. (1864) (*Phora*)
?Neuhaus, Dipt. March., p. 342. (1886) (*Phora heracleelae*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 60, fig. (1901) (*Phora*)
Wood, Entom. Monthly Mag., vol. 20, p. 117, 145. (1909) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 122. (1910)
spinata Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 150, 198. (1910) (*Phora*)
spreta Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 115, fig. (1912)
spinicincta Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 245, 248. (1910) (*Phora*)
spinigera Wood. England.
Entom. Monthly Mag., vol. 19, p. 174, 217. (1908) (*Phora*)
spinifemorata Malloch. Jamaica.
Proc. U. S. Nat. Mus., vol. 43, p. 465, fig. (1912)
straminea Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 472. (1912)
straminipes Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 474. (1912)
subatomella Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 48, fig. (1912)
subciliata Malloch. U. S. A.
Psyche, vol. 20, p. 26. (1913)
subflava Malloch. Porto Rico.
Proc. U. S. Nat. Mus., vol. 43, p. 469. (1912)
subfurcata Brunetti. India.
Rec. Indian Mus., vol. 7, p. 508. (1912)
sublutea Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 468. (1912)
submanicata Malloch. U. S. A.
Entomol. News, vol. 25, p. 175. (1914)
submarginalis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 456. (1912)
subobscurata Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 485. (1912)
subpicta Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 452, fig. (1912)
subpleuralis Wood. England.
Entom. Monthly Mag., vol. 20, p. 118, 146. (1909) (*Phora*)

subtumida Wood. England.
Entom. Monthly Mag., vol. 20, p. 195, 244. (1909) (*Phora*)
sulphuripes Meigen. Europe; N. Amer.; S. Amer.
Syst. Beschr., vol. 6, p. 219 (22). (1830) (*Phora*)
Meigen, ibid., vol. 6, p. 219 (23). (1830) (*P. bicolor*)
Meigen, ibid., vol. 6, p. 220 (25). (1830) (*Phora lutea*)
Fallen, Dipt. Suec. Phytom., p. 7. (1823) (*Trineura flava* p.p.)
Macquart, Suit. à Buff., vol. 2, p. 628. (1835) (*Phora lutea*)
Macquart, Suit. à Buff., vol. 2, p. 628. (1835) (*Phora bicolor*)
Macquart, Suit. à Buff., vol. 2, p. 628. (1835) (*Phora flava* p.p.)
Zetterstedt, Ins. Lapp, p. 797. (1838) (*Trineura lutea*)
Boitard, Nouv. Man. Entom., vol. 3, p. 522. (1843) (*Phora*)
Zetterstedt, Dipt., Scand., vol. 7, p. 2877. (1848) (*Trineura lutea*)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1137. (1849) (*Phora lutea*)
Strobl, Wien. Ent. Zeits., vol. 11, p. 196. (1892) (*Phora lutea*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 54, fig. (1901) (*Phora lutea*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 70. (1901) (*Phora bicolor*)
Strobl, Mitth. Naturwiss. Ver. Steiermark, vol. 30, p. 15. (1894) (*Phora lutea*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 362, fig. (1903) (*lutea*)
Brues, Ann. Mus. Nat. Hungarici, vol. 3, p. 399. (1905) (*lutea*)
Wood, Entom. Monthly Mag., vol. 20, p. 120 and 148, fig. (1909) (*Phora lutea*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 121. (1910) (*lutea*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 471. (1912) (*lutea*)
Becker, Suppl. Entomologica, no. 3, p. 90. (1914) (*lutea*)
Malloch, Trans. Amer. Ent. Soc., vol. 40, p. 34. (1914) (*lutea*)
superciliata Wood. England.
Ent. Monthly Mag., 2nd ser., vol. 21, p. 244, 247. (1910) (*Phora*)
surdifrons Wood. England.
Entom. Monthly Mag., vol. 20, p. 26, 62. (1909) (*Phora*)
sylvatica Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 245, 248. (1910) (*Phora*)
sylvicola Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 30. (1914)
tarsalis Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 243, 246. (1910) (*Phora*)
Wood, ibid., vol. 23, p. 171. (1912) (*Phora*)
tarsata Brues. Peru.
Ann. Mus. Nat. Hungarici, vol. 3, p. 397. (1905)
tasmaniensis Malloch. Tasmania.
Proc. U. S. Nat. Mus., vol. 43, p. 514. (1912)
tertia nom. nov. U. S. A.
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 464. (1912) (*inæqualis* Malloch, non Brunetti.)

tibialis Brues. India.
Ann. Mus. Nat. Hungarici, vol. 3, p. 545. (1905)
trilineata Brunetti. India.
Rec. Indian Mus., vol. 7, p. 510. (1912)
trivialis Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 544, fig. (1911)
tumida Wood. England.
Entom. Monthly Mag., vol. 20, p. 192, 242. (1909) (*Phora*)
uliginosa Wood. England.
Entom. Monthly Mag., vol. 20, p. 28, 63. (1909) (*Phora*)
umbripennis Brues. Brazil.
Enderlein, Stettiner Ent. Zeit., p. 37. (1912) (*fumipennis* Enderl. nec Brues)
Brues, Psyche, vol. 19, p. 136. (1912)
unguicularis Wood. England.
Entom. Monthly Mag., vol. 20, p. 115, 144. (1909) (*Phora*)
Wood, ibid., vol. 23, p. 168. (1912) (*Phora*)
ursina Malloch. Canada.
Proc. U. S. Nat. Mus., vol. 43, p. 476. (1912)
variabilis Wood. England.
Entom. Monthly Mag., vol. 20, p. 118, 146. (1909)
variata Malloch. Philippines.
Proc. U. S. Nat. Mus., vol. 43, p. 515. (1912)
vernalis Wood. England.
Entom. Monthly Mag., vol. 20, p. 119, 147. (1909) (*Phora*)
verralli Wood. England.
Ent. Month. Mag., 2nd ser., vol. 21, p. 150, 198. (1910) (*Phora*)
viduata Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 111, fig. (1912)
vulgaris Fallen = *rufipes* Meig.
Dipt. Suec. Phytom., p. 6. (1823) (*Trineura*)
vulgata Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 483. (1912)
winnemana Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 461. (1912)
xanthina Speiser. Kamerun.
Berliner. Entom. Zeitschr., vol. 52, p. 148. (1907)
Brues, Psyche, vol. 17, p. 36. (1910)
xantippe Banks = *juli* Brues.
xanthozona Strobl. Europe.
Wien. Entom. Zeitng., vol. 11, p. 203. (1892) (*Phora*)
Strobl, Mitth. Naturwiss. Ver. Steiermark, vol. 30, p. 17. (1894) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 64. (1901) (*Phora*)
Strobl, Mem. R. Soc. Espan. Hist. Nat., vol. 3, p. 334. (1906) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 123. (1910)
zonata Zett. Europe.
Ins. Lapp., p. 796. (1838) (*Trineura*)

Zetterstedt, Dipt. Scand., vol. 7, p. 2862. (1848) (*Trineura*)
Wulp, Tijdschr. Entom., vol. 6, p. 208. (1871) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 59. (1901) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 121. (1910)

Paraphiochaeta Malloch

1914. Trans. Amer. Ent. Soc., vol. 40, p. 27.

Type: *P. biseriata* Malloch

biseriata Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 27, fig. (1914)
The following species listed under Aphiochaeta belong here if Paraphiochaeta be recognized as distinct. Its separation came too late, however, to make any change in the present catalogue. **barberi, fasciata, giraudii, halictorum, meigeni, nedae, picta, subpicta.**

Phalacrotophora Enderlein

1912. Stettiner. Ent. Zeit., p. 51.
1912. Brues, Psyche, vol. 19, p. 135.
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 518.

Type: *P. bruesiana* Enderlein

bruesiana Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 21.
epeirae Brues. U. S. A.
Psyche, vol. 10, p. 351. (1902)
Slosson, Ent. News, vol. 6, p. 7. (1895) (*Phora fasciata*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 358, fig. (1903)
Brues, Psyche, vol. 19, p. 135. (1912)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 450, 518. (1912)
longifrons Brues. U. S. A.
Bull. Wisconsin Nat. Hist. Soc., vol. 4, p. 100. (1906)
Brues, Psyche, vol. 19, p. 135. (1912)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 449, 518. (1912)

Byrsophrys Enderlein

1912. Stettiner Ent. Zeit., p. 50.

Type: *B. boliviana* Enderlein

boliviana Enderlein. Boliva.
Stettiner Ent. Zeit., 1912, p. 51.

Parasyneura Malloch

1912. Proc. U. S. Nat. Mus., vol. 43, p. 516. (1912)

Type: *P. rotundipennis* Malloch

rotundipennis Malloch. Java.
Proc. U. S. Nat. Mus., vol. 43, p. 516, fig. (1912)

Plastophora Brues

1905. Ann. Mus. Nat. Hungarici, vol. 3, p. 551.
1906. Brues, Genera Ins., fasc. 44, p. 11.
1907. Coquillett, Pseudacteon Canadian Ent., vol. 39, p. 208.
1907. Brues, Ent. News, vol. 18, p. 430.
1908. Wood, Entom. Monthly Mag., vol. 19, p. 168. (*Phora, Aphiochaeta, Plastophora, Pseudacteon*)
1908. Brues, in Williston's Man. N. Amer. Dipt., Ed. 3, p. 239.
1908. Brues, Journ. New York Ent. Soc., vol. 16, p. 200.
1912. Brues, Psyche, vol. 19, p. 136.
1912. Collin, Trans. Linn. Soc. London, vol. 15, p. 109. (1912)

Type: *P. beirne* Brues

aculeipes Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 108, fig. (1912) (*Aphiochaeta*)
antiguensis Malloch. West Indies.
Proc. U. S. Nat. Mus., vol. 43, p. 502, fig. (1912)
beirne Brues. New Guinea.
Ann. Mus. Nat. Hungarici, vol. 3, p. 552. (1905)
Brues, Ent. News., vol. 18, p. 430. (1907)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 500. (1912)
crawfordi Coq. U. S. A.
Canad. Ent., vol. 39, p. 208. (1907) (*Pseudacteon*)
Brues, Ent. News, vol. 18, p. 430. (1907)
Wheeler, Ants, their Structure, Develop. and Habits, p. 419. (1910)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 501, fig. (1912)
Wood, Entom. Monthly Mag., vol. 19, p. 168. (1908) (*Pseudacteon*)
curriei Malloch. Canada.
Proc. U. S. Nat. Mus., vol. 43, p. 501, fig. (1912)
formicarum Verrall. England.
Journ. Linn. Soc. London. Zool., vol. 13, p. 258. (1877) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 68. (1901) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 375. (1903) (*Melaloncha?*)
Brues, Ann. Mus. Nat. Hungarici, vol. 3, p. 552. (1905) (*Phora*)
Brues, Ent. News, vol. 18, p. 430. (1907)
Wood, Entom. Monthly Mag., vol. 19, p. 168, 174, fig. (1908) (*Phora*)
Strobl, Mitt. Naturwiss. Ver. Steiermark, vol. 46, p. 125. (1910)
Donisthorpe, Zoologist, 1909, p. 466. (Phora)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 501, fig. (1912)
Schmitz, Naturhist. Genootschap, Limburg Jaarboek, 1913, p. 6. (*Pseudacteon*)

mera Collin. Seychelles.
Trans. Linn. Soc. London, vol. 15, p. 109. (1912) (*Aphiochaeta*)
solenopsidis Schmitz. Brazil.
Zool. Jahrb., Abth. f. Syst., vol. 37, p. 531. (1914)
spatulata Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 502, fig. (1912)
wasmanni Schmitz. Brazil.
Zool. Jahrb., Abth. f. Syst., vol. 37, p. 528. (1914)

Pronomiophora Enderlein

1912. Stettiner Ent. Zeit., p. 16 and 46.
1913. Malloch, Psyche, vol. 20, p. 23 and 24.

Type: *P. rostrata* Enderlein

rostrata Enderlein. German East Africa.
Stettiner Ent. Zeit., 1912, p. 46.

Psyllomyia Loew.

1857. Wiener Entom. Monatsschr., vol. 1, p. 54.
1901. Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 87.
1901. Brues, American Natural., vol. 35, p. 343.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 385.
1906. Brues, Genera Ins., fasc. 44, p. 14.

Type: *P. testacea* Lw.

testacea Lw. Cape Colony.
Wiener Entom. Monatsschr., vol. 1, p. 54. (1857)
Brues, Amer. Naturalist, vol. 35, p. 343, fig. (1901)
Becker, Abh. zool.-bot. Ges. Wien., vol. 1, p. 87. (1901)
Brues, Psyche, vol. 17, p. 36. (1910)
Schmitz, Zool. Jahrb., Abth. f. Syst., vol. 37, p. 522, fig. (1914)

Gymnophora Macquart

1835. Suit. à Buffon, vol. 2, p. 631. 1840. Westwood, Introd. Mod. Class.
1856. Rondani, Prodr. Dipt. Ital., p. 137. Ins., vol. 2, p. 154.
1864. Lioy, Atti Istit. Venet., vol. 10, p. 79.
1864. Schiner, Dipt. Austr., vol. 2, p. 346.
1901. Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 82.
1903. Brues, Trans. Amer. Entom. Soc., vol. 29, p. 381.
1908. Brues, in Williston's Man. N. Amer. Dipt. Ed. 3, p. 239.
1910. Malloch, Ann. Scottish Nat. Hist., p. 17.
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 500.

Type: *G. arcuata* Meig.

arcuata Meigen. Europe; N. Amer.
Syst. Beschr., vol. 6, p. 222, fig. (1830) (*Phora*)

?Meigen, ibid., t.c.p. 215. (1830) (*Phora fuliginosa*)
Fallen, Dipt. Suec. Phytom., p. 5. (1823) (*Trineura rufipes*, nec Meigen)
Haliday, Entom. Mag., vol. 1, p. 179. (1833) (*Phora debilis*)
Macquart, Suit. à Buff., vol. 2, p. 631, fig. (1835)
Zetterstedt, Ins. Lapp., p. 795. (1838) (*Trineura*)
Blanchard, Hist. Nat. Ins., vol. 3, p. 630. (1840)
Boitard, Nouv. Man. Entom., vol. 3, p. 522. (1843)
Zetterstedt, Dipt. Scand., vol. 7, p. 2845. (1848)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1137. (1849)
Dahlbom, Kongl. Vet. Akad. Handl., 1850, p. 164. (1851)
Walker, Ins. Brit., vol. 2, p. 282. (1853) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 346. (1864)
Lioy, Atti. Istit. Ven., vol. (3) 10, p. 79. (1864)
Strobl, Wien, Ent. Zeitg., vol. 11, p. 204. (1892)
Strobl, Mitth. Naturwiss. Ver. Steiermark, vol. 30, p. 17. (1894)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 82. (1901)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 381, fig. (1903)
Malloch, Ann. Scottish Nat. Hist., p. 17. (1910)
Brues, Ann. Mus. Nat. Hungarici, vol. 9, p. 441. (1911)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 500. (1912)

colona Brues. Paraquay.
Ann. Mus. Nat. Hungarici, vol. 9, p. 441. (1911)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 500. (1912)

cymatoneura Enderlein. Brazil.
Stettiner Ent. Zeit., 1912, p. 23.

debilis Haliday = *arcuata* Meig.
Entom. Mag., vol. 1, p. 179. (1833) (*Phora*)

fuliginosa Meigen. = ?*arcuata* Meig.
Syst. Reschr., vol. 6, p. 215. (1830) (*Phora*)
Macquart, Suit. à Buff., vol. 2, p. 626. (1835) (*Phora*)
Boitard, Nouv. Man. Entom., vol. 3, p. 521. (1843) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 72. (1901)

rufipes Fallen = *arcuata* Meig.
Dipt. Suec. Phytom., p. 5. (1823) (*Trineura rufipes* Fallen, nec Meigen)

Metopina Macq.

1835. Suit. à Buffon, vol. 2, p. 666.
1878. Six, Tijdschr. Entom., vol. 21, p. 186. (*Leptophora*)
1880. Strobl. Program. Seitenst., vol. 14, p. 40. (*Drepanophora*)
1901. Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 83.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 384.
1906. Brues, Genera Ins., fasc. 44, p. 12.
1908. Brues, in Williston's Man. N. Amer. Dipt., Ed. 3, p. 239.
1910. Malloch, Ann. Scottish Nat. Hist., p. 92.

Type: *M. galeata* Haliday

braueri Strobl = *galeata* Hal.
Program Seitenst., vol. 14, p. 40. (1880) (*Drepanophora*)
fenyesi Malloch. Mexico.
Proc. U. S. Nat. Mus., vol. 43, p. 503, fig. (1912)
galeata Haliday. Europe.
Entom. Mag., vol. 1, p. 179. (1833) (*Phora*)
Curtis, Brit. Entom., vol. 8, p. 437. (1833) (*Phora*)
Macquart, Suit. à Buff., vol. 2, p. 666. (1835)
Meigen, Syst. Beschr., vol. 7, p. 414. (1838)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1138. (1849) (*Phora*)
Walker, Ins. Brit., vol. 2, p. 282. (1853) (*galatea*)
Walker, ibid., vol. 3, p. xiv. (1855) (*Phora*)
Mik, Verh. zool.-bot. Ges. Wien, vol. 17, p. 414, fig. (1867) (*Phora oligoneura*)
Six, Ned. Tijd. Entom., vol. 21, p. 186. (1878) (*Leptophora perpusilla*)
Wulp, Tijd. Entom., vol. 22, p. xc. (1879) (*Phora oligoneura*)
Strobl, Programm Seitenst., vol. 14, p. 40. (1880) (*Drepanophorâ braueri*)
Mik, Verh. zool.-bot. Ges. Wien, vol. 31, p. 348. (1881) (*Leptophora oligoneura*)
Mik, in Beck; Fauna von Hernstein, vol. 2, p. 65. (1885) (*Leptophora oligoneura*)
v. Röder, Wien. Ent. Zeitg., vol. 6, p. 288. (1887)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 83, fig. (1901)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 384. (1903)
Malloch, Ann. Scottish Nat. Hist., p. 92. (1910)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 504. (1912)
heselhausi Schmitz. Europe.
Zeits. Wiss. Insektenbiol., vol. 10, p. 91. (1914)
oligoneura Mik = *galeata* Hal.
Verh. zool.-bot. Ges. Wien, vol. 17, p. 414. (1867) (*Phora*)
pachycondylae Brues. U. S. A. (Texas).
Trans. Amer. Ent. Soc., vol. 29, p. 384. (1903)
Wheeler, Amer. Naturalist, vol. 35, p. 1007, fig. (1901) (*sine nom.*)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 503. (1912)
perpusilla Six = *galeata* Hal.
Ned. Tidskr. Entom., vol. 21, p. 186. (1878) (*Leptophora*)

Puliciphora Dahl.

1897. Zool. Anz., vol. 20, p. 410.
1898. Dahl, ibid., vol. 21, p. 308.
1898. Wandolleck. Zool. Jahrb. Abth. f. Syst., vol. 11, p. 424. (*Stethopathus*)
1901. Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 85.

1901. Brues American Natural., vol. 35, p. 354. (*Stethopathus*)
1903. Melander & Brues, Biol. Bull, vol. 5, p. 17.
1903. Brues. Trans. Amer. Ent. Soc., vol. 29, p. 390.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 382. (*Pachyneurella*) ♂.
1906. Brues, Genera Ins., fasc. 44, p. 14.
1908. Brues, in Williston's Man. N. Amer. Dipt. Ed. 3, p. 240.
1909. Trägårdh, Zool. Jahrb. Abth. f. Syst., vol. 28, p. 229. (*Cryptopteromyia*)
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 504.
1913. Schmitz, Entom. Meddel., vol. 10, p. 10. (1913) (*Termitophora*)

Type: *P. lucifera* Dahl.

africana Brues. German East Africa.
Ann. Mus. Nat. Hungarici, vol. 5, p. 410, fig. (1907)
Brues, Psyche, vol. 17, p. 36. (1910)
beckeri de Meijere. Java.
Tijdschr. Ent., vol. 5, p. 253. (1907)
De Meijere. Zool. Jahrb. Suppl. 15, p. 141, figs.
borinquenensis Wheeler. Porto Rico; Bahamas.
Bull. Amer. Nat. Mus. Hist., vol. 22, p. 269, figs. (1906)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 506. (1912) (*borinquensis*)
?exempta Becker. Europe.
Abh. zool.-bot. Ges. Wien, vol. 1, p. 49. (1901) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 383. (1903) (*Syneura?*)
Speiser, Schr. Physik.-ökonöm. Ges. Königsberg, vol. 47, p. 74. (1906) (*Syneura*)
flava Malloch. Costa Rica.
Trans. Amer. Ent. Soc., vol. 40, p. 34. (1914)
glacialis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 507, fig. (1912)
incerta Silvestri. Mexico.
Boll. Lab. Zool. Gen. and Agr., R. Scuola Agr., Portici, vol. 5, p. 174, figs. (1911)
jeanssoni Trägårdh. Natal.
Zool. Jahrb. Abth. f. Syst., vol. 28, p. 330. (1909) (*Cryptopteromyia*)
Brues, Psyche, vol. 17, p. 36. (1910) (*Cryptopteromyia*)
kertészii Brues. Formosa.
Ann. Mus. Nat. Hungarici, vol. 9, p. 557, figs. (1911)
lucifera Dahl. East Indies.
Zool. Anz., vol. 20, p. 411. p.p. (1897)
SB. naturf. Freunde, p. 185. (1898) (Wandolleck, Zool. Jahrb. Abth. f. Syst., vol. 11, p. 424. (1898) (*Stethopathus ocellatus*)
Austen, Ann. Mag. Nat. Hist., vol. 1, p. 99. (1898)
Mik, Wien. Entom. Zeitg., vol. 18, p. 204. (1898)
Heymons, Zool. Anz., vol. 22, p. 223. (1899)
Brues, Amer. Naturalist, vol. 35, p. 354. (1901) (*Stethopathus ocellatus*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 85. (1901)

Dahl, Archiv f. Naturgesch, vol. 45, p. 1, fig. (1899)
Kertész, Rovartani Lapok, vol. 5, p. 198, fig. (1898) (*Stethopathus ocellatus*)

matheranensis Brues. India.
Ann. Mus. Nat. Hungarici, vol. 5, p. 409, fig. (1907)

nitida Malloch. Guatemala.
Proc. U. S. Nat. Mus., vol. 43, p. 508, fig. (1912)

nudipalpis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 504, fig. (1912)

obtecta de Meijere. Java.
Zool. Jahrb. Suppl. 15, p. 148, fig. (1912)

occidentalis Melander and Brues. U. S. A.
Biological Bull., vol. 5, p. 17. (1903)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 391. (1903)
Barber, Proc. Entom. Soc. Washington, vol. 7, p. 2. (1905)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 507. (1912)

ocellata Wandolleck = *lucifera* Dahl.
Zool. Jahrb. Abth. f. Syst., vol. 11, p. 441, fig. (1898) (*Stethopathus*)

palposa Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 505, fig. (1912)

pulex Dahl. East Indies.
SB. naturf. Freunde, p. 186. (1898)
Dahl, Archiv f. Naturgesch., vol. 45, p. 1. (1899)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 85. (1901)

pusillima de Meijere. Sumatra.
Zool. Jahrb. Suppl., 15, p. 149, figs. (1912)

sylvatica Brues. U. S. A.
Bull. Wisconsin Nat. Hist. Soc., vol. 7, p. 107. (1909)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 506. (1912)

velocipes Schmitz. India.
Wasmann, Biol. Centralbl., vol. 31, p. 402. (1911) (sine descrip.)
Schmitz, Entom. Meddel., vol. 10, p. 13. (1913) (*Termitophora*)

venata Aldrich. West Indies.
Trans. Entom. Soc. London, p. 436. (1896) (*Phora*)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 382, fig. (1903) (*Pachyneurella*)

virginiensis Malloch. U. S. A.
Proc. U. S. Nat. Mus., vol. 43, p. 519. (1912) ♂.

Myrmomyia Silvestri

1911. Boll. Lab. Zool. Gen. Agr. Sc. Sup. Agr. Portici, vol. 5, p. 175.

Type: *M. brachymyrmecis* Silvestri

brachymyrmecis Silvestri. Mexico.
Boll. Lab. Zool. Gen. and Agr., R. Scuola Agr., Portici, vol. 5, p. 176, figs. (1911)

Hexacantherophora Schmitz

1914. Zool. Jahrb., Abth. f. Syst., vol. 37, p. 512.

Type: *H. cohabitans* Schmitz

cohabitans Schmitz. Belgian Congo.
Zool. Jahrb., Abth. f. Syst., vol. 37, p. 512, fig. (1914)

Ecitophora Schmitz.

1914. Zool. Jahrb., Abth. f. Syst., vol. 37, p. 524.

Type: *E. comes* Schmitz

comes Schmitz. Brazil.
Zool. Jahrb., Abth. f. Syst., vol. 37, p. 524, fig. (1914)

Commoptera Brues

1901. American Natural., vol. 35, p. 344.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 385.
1906. Brues, Genera Ins., fasc. 44, p. 14.
1908. Brues, in Williston's Man. N. Amer. Dipt., Ed. 3, p. 239.

Type: *C. solenopsidis* Brues

solenopsidis Brues. U. S. A. (Texas).
American Naturalist, vol. 35, p. 344. (1901)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 386, figs. (1903)
Wheeler, Ants, Their Structure, Develop. and Habits, p. 383. (1910)

Ecitomyia Brues

1901. American Natural., vol. 35, p. 347, figs.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 387.
1906. Genera Ins., fasc. 44, p. 15.
1908. Brues, in Williston's Man. N. Amer. Dipt., Ed. 3, p. 240.

Type: *E. wheeleri* Brues

wheeleri Brues. U. S. A. (Texas)
American Naturalist, vol. 35, p. 347, figs. (1901)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 388. (1903)
Brues, Biol. Bull., vol. 4, p. 188, fig. (1903)
Wheeler, Ants, Their Structure, Develop. and Habits, p. 383. (1910)

Acontistoptera Brues

1902. American Natural., vol. 36, p. 373.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 388.
1906. Brues, Genera Ins. Fasc. 44, p. 15.
1908. Brues, in Williston's Man. N. Amer. Dipt., Ed. 3, p. 240.

1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 509.
1914. Schmitz, Zool. Jahrb., Abth. f. Syst., vol. 37, p. 526.

Type: *A. melanderi* Brues

brasiliensis Schmitz. Brazil.
Zool. Jahrb., Abth. f. Syst., vol. 37, p. 527. (1914)
melanderi Brues. U. S. A. (Texas).
American Naturalist, vol. 36, p. 374. (1902)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 389, figs. (1903)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 508. (1912)
mexicana Malloch. Mexico.
Proc. U. S. Nat. Mus., vol. 43, p. 509, fig. (1912)

Xanionotum Brues

1902. Amer. Natural., vol. 36, p. 376.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 389.
1906. Brues, Genera Ins., fasc. 44, p. 16.
1908. Brues, in Williston's Man. N. Amer. Dipt., Ed. 3, p. 240.
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 510.

Type: *X. hystrix* Brues

hystrix Brues. U. S. A. (Texas).
Amer. Natural., vol. 36, p. 377, figs. (1902)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 390. (1903)
Wheeler, Ants, Their Structure, Develop. and Habits, p. 383. (1910)

Rhynchomicropteron Annandale

1912. Spolia Zeylandica, vol. 8, p. 86.
1914. Schmitz, Zool. Jahrb., Abth. f. Syst., vol. 37, p. 515.

Type: *R puliciforme* Annandale

caecutiens Schmitz. India.
Zool. Jahrb., Abth. f. Syst., vol. 37, p. 519. (1914)
puliciforme Annandale. Ceylon.
Spolia Zeylandica, vol. 8, p. 86. (1912)

Chonocephalus Wandolleck

1897. Dahl, Zool. Anz., vol. 20, p. 409. (Puliciphora) ♀.
1898. Wandolleck, Zool. Jahrb., Abth. f. Syst., vol. 11, p. 428.
1901. Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 86.
1901. Brues, American Natural., vol. 35, p. 355.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 391.
1906. Brues, Gen. Ins., fasc. 44, p. 12.
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 510.

Type: *C. dorsalis* Wand.

buccata Malloch. Guatemala.
Proc. U. S. Nat. Mus., vol. 43, p. 510, fig. (1912)
depressus de Meijere. Sumatra.
Zool. Jahrb. Suppl, 15, p. 151, figs. (1910)
fletcheri Schmitz. India.
Zool. Anz., vol. 39, p. 728, fig. (1912)
dorsalis Wandolleck. Bismarck, Archipelago.
Dahl, Zool. Anz., vol. 20, p. 411. (1897) (*Puliciphora lucifera* p.p.)
Wandolleck, Zool. Jahrb., Abth. f. Syst., vol. 11, p. 448. (1898)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 86, fig. (1901)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 391. (1903)
Brues, Ann. Mus. Nat. Hungarici, vol. 5, p. 409. (1907)
kiboshoënsis Brues. German East Africa.
Ann. Mus. Nat. Hungarici, vol. 5, p. 410, fig. (1907)
Brues, Psyche, vol. 17, p. 36. (1910)
mexicanus Silvestri. Mexico.
Boll. Lab. Zool. Gen. and Agr. R. Scuola Agri., Portici, vol. 5, p. 172, figs. (1911)
Collin, Trans. Linn. Soc. London, vol. 15, p. 105. (1912)
similis Brues. India; Seychelles.
Ann. Mus. Nat. Hungarici, vol. 3, p. 554. (1905)
Collin, Trans. Linn. Soc. London, vol. 15, p. 105. (1912)

Wandolleckia Cook

1897. Science, vol. 6, p. 886.
1898. Wandolleck. Zool. Jahrb., Abth. f. Syst., vol. 11, p. 417.
1901. Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 87.
1901. Brues, Amer. Natural., vol. 25, p. 339.
1906. Brues, Genera Ins., fasc. 44, p. 16.

Type: *W. cooki* Brues

cooki Brues. West Africa.
Trans. Amer. Ent. Soc., vol. 29, p. 392. (1904)
Brues, Psyche, vol. 17, p. 36. (1910)
indomita Brues. German East Africa.
Ann. Mus. Nat. Hungarici, vol. 5, p. 412. (1907)
Brues, Psyche, vol. 17, p. 36. (1910)

Aenigmatias Meinert

1890. Entom. Meddel., vol. 2, p. 213.
1901. Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 89.
1901. Brues, American Natural., vol. 35, p. 342.
1903. Coquillett, Canadian Entom., vol. 25, p. 20.
1903. Brues, Trans. Amer. Entom. Soc., vol. 29, p. 386.

1906. Brues, Gen. Ins., fasc. 44, p. 13.
1908. Enderlein, Zool. Jahrb. Abth. f. Syst., vol. 27, p. 148. (1908)
ibid, &c., p. 150. (*Onisomyia*)
1908. Brues, in Willistin's Man. N. Amer. Dipt., Ed. 3, p. 240.
1912. Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 510.
1914. Schmitz, Zool. Jahrb., Abth. f. Syst., vol. 37, p. 544.

Type: *Ae. blattoides* Meinert

blattoides Meinert. Europe.
Ent. Meddel., vol. 2, p. 213, figs. (1890)
Wasmann, Krit. Verzeich. Myrmec. and Termitoph., p. 32, 175. (1894)
Dahl, SB. Naturf. Freunde, Berlin, 1898, p. 193, fig. (1898)
Dahl, Archiv. f. Naturgesch., vol. 45, p. 1, fig. (1899)
Bezzi, Rendic. Ist. Lomb. Sc. Lett., vol. 33, p. 11. (1900)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 89. (1901)
Coquillett, Canadian Entom., vol. 35, p. 21. (1903)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 387. (1903)
Enderlein, Zool. Jahrb., Abth. f. Syst., vol. 27, p. 149, figs. (1908)
Shelford, Journ. Linn. Soc. London, vol. 30, p. 150. (1908)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 511. (1912)
blattoides var. **highlandica** Schmitz. Europe.
Zool. Jahrb., Abth. f. Syst., vol. 37, p. 543. (1914)
dorni Enderlein. Europe.
Zool. Jahrb., Abth. f. Syst., vol. 27, p. 150, fig. (1908) (*Oniscomyia*)
Schmitz, ibid., vol. 37, p. 544. (1914)
schwarzii Coquillett. U. S. A. (Arizona).
Canadian Entom., vol. 35, p. 21. (1903)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 387. (1903)
Enderlein, Zool. Jahrb., Abth. f. Syst., vol. 27, p. 149. (1908)
Shelford, Journ. Linn. Soc. London, vol. 30, p. 152. (1908)
Malloch, Proc. U. S. Nat. Mus., vol. 43, p. 510. (1912)

Aenigmatistes Shelford

Journ. Linn. Soc. Zool., vol. 30, p. 150. (1908)
Enderlein, Zool. Jahrb., Abth. f. Syst., vol. 27, p. 153. (1908)

Type: *Ae. africanus* Shelford

africanus Shelford. British Central Africa.
Journ. Linn. Soc., Zool., vol. 30, p. 151, figs. (1908)
Enderlein, Zool. Jahrb., Abth. f. Syst., vol. 27, p. 153. (1908)
Brues, Psyche, vol. 17, p. 36. (1910)

Aenigmatopoeus Schmitz

1914. Zool. Jahrb., Abth. f. Syst., vol. 37, p. 534.

Type: *Ae. orbicularis* Schmitz

orbicularis Schmitz. Kamerun.
Zool. Jahrb., Abth. f. Syst., vol. 37, p. 536. (1914)

Thaumatoxena Breddin and Börner

1904. SB. naturf. Freunde, Berlin, p. 84, figs.
1906. Silvestri, Redia, vol. 3, p. 350, figs.
1908. Enderlein, Zool. Jahrb., Abth. f. Syst., vol. 27, p. 154.
1909. Trägårdh, Arkiv. f. Zool., vol. 4, No. 10, p. 1.
1909. Zool. Jahrb., Abth. f. Syst., vol. 28, p. 339.

Type: *T. wasmanni* Bred. and Börn.

wasmanni Breddin and Börner. Natal.
SB. Gesellsch. naturf. Freunde, Berlin, 1904, p. 87, figs.
Börner, Zool. Anz., vol. 27, p. 511. (1904)
Silvestri, Redia, vol. 3, p. 359. (1906)
Bredd. and Börn., Zool. Anz., vol. 32, p. 537, figs. (1908)
Brues, Psyche, vol. 17, p. 36. (1910)
Trägårdh, Zool. Jahrb., Abth. f. Syst., vol. 28, p. 339. (1909)
Trägårdh, Arkiv. f. Zool., vol. 4, No. 10, p. 1, figs. (1909)

Termitodeipnus Enderlein

1905. Silvestri, Redia, vol. 3, p. 350. (*Thaumatoxena*)
1908. Zool. Jahrb., Abth. f. Syst., vol. 27, p. 154.
1909. Trägårdh, Arkiv. f. Zool., vol. 4, No. 10. p. 1.
1909. Trägårdh, Zool. Jahrb. Abth. f. Syst., vol. 28, p. 339.

Type: *T. andreinii* Silvestri

andreinii Silvestri. Eritrea.
Redia, vol. 3, p. 356, figs. (1906) (*Thaumatoxena*)
Börner, Zool. Anz., vol. 32, p. 537. (1908) (*Thaumatoxena*)
Enderlein, Zool. Jahrb., Abth. f. Syst., vol. 27, p. 154. (1908)
Brues, Psyche, vol. 17, p. 36. (1910)
Trägårdh, Arkiv. f. Zool., vol. 4, No. 10, p. 1, figs. (1909) (*Thaumatoxena*)
Trägårdh, Zool. Jahrb., Abth. f. Syst., vol. 28, p. 339. (1909)

Bolsiusia Schmitz

1913. Zool. Anz., vol. 42, p. 268.

Type: *B. termitophila* Schmitz

termitophila Schmitz. India.
Zool. Anz., vol. 42, p. 268, figs. (1913)

Eutermiphora Lea

Proc. Roy. Soc. Victoria, vol. 24 (N.S.) Pt. 1, p. 76. (1911)

Type: *E. abdominalis* Lea

abdominalis Lea. New South Wales.
Proc. Roy. Soc. Victoria, vol. 24 (N.S.) Pt. 1, p. 77, fig. (1911)

Termitoxenia Wasmann

1900. Zeitschr. wiss. Zool., vol. 67, p. 599.
1901. Wasmann, ibid., vol. 70, p. 289.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 395.
1906. Brues, Genera Ins. Fasc. 44, p. 16.
1913. Bugnion, Ann. Soc. Entom. Belgique, vol. 57, p. 31.

Type: *T. havilandi* Wasmann

assmuthi Wasmann. Ceylon.
Zool. Jahrb., Abth. f. Syst., vol. 17, p. 151. (1902)
Wasmann, Verh. Deutsch. Zool. Ges., vol. 13, p. 113, figs. (1903)
Bugnion, Ann. Soc. Entom. Belgique, vol. 52, p. 24. (1913)
bugnioni Wasmann. Ceylon.
Ann. Soc. Entom. Belgique, vol. 52, p. 20. (1913)
Bugnion. Ann. Soc., Entom. Belgique, vol. 57, p. 31. (1913)
butteli Wasmann.
Ann. Soc. Entom. Belgique, vol. 57, p. 20. (1913)
havilandi Wasmann. Natal.
Zeitschr. wiss. Zool., vol. 67, p. 609, fig. (1900)
Brues, Psyche, vol. 17, p. 36. (1910)
Bugnion, Ann. Soc. Entom. Belgique, vol. 52, p. 24. (1913)
heimi Wasmann. E. India.
Zeitschr. wiss. Zool., vol. 67, p. 610. (1900)
Wasmann, ibid., vol. 70, p. 295. (1901)
Wasmann, Zool. Jahrb., Abth. f. Syst., vol. 17, p. 159, fig. (1902)
Wasmann. Verh. d. 5ten. Internat. Zool. Congress. Berlin, p. 852. (1902)
Wasmann, Verh. Deutsch. Zool. Ges., vol. 13, p. 113, fig. (1903)
Bugnion, Ann. Soc. Entom. Belgique, vol. 52. (1913)
jaegerskioeldi Wasmann. Africa.
Results Swedish Exped. Egypt and White Nile. No. 13, p. 16. (1904)
Brues, Psyche, vol. 17, p. 36. (1910)
Bugnion, Ann. Soc. Entom. Belgique, vol. 52, p. 24. (1913)
peradeniyae Bugnion. Ceylon.
Bugnion, Ann. Soc. Entom. Belgique, vol. 57, p. 31. (1913)

Termitomyia Wasmann

1900. Zeitschr. wiss. Zool., vol. 67, p. 599.
1906. Brues, Genera Ins., fasc. 44, p. 17.

Type: *T. mirabilis* Wasmann

braunsi Wasmann. Orange Free State.
Zeitschr. wiss. Zool., vol. 67, p. 611. (1900) (*Termitoxenia*)
Wasmann, Verh. 5ten. Internat. Zool. Congress., Berlin, p. 852. (1902)
Bugnion, Ann. Soc. Entom. Belgique, vol. 52, p. 24. (1913)
Brues, Psyche, vol. 17, p. 36. (1910)
mirabilis Wasmann. Natal.
Zeitschr. wiss. Zool., vol. 67, p. 611. (1900)
Wasmann, ibid., vol. 70, p. 295. (1901)
Wasmann, Verh. 5ten. Internat. Congress., Berlin, p. 852, fig. (1903)
Wasmann, Verh. Deutsch. Zool. Ges., vol. 13, p. 113, fig. (1903)
Brues, Psyche, vol. 17, p. 36. (1910)
Bugnion, Ann. Soc. Entom. Belgique, vol. 52, p. 24. (1913)

Termitosphaera Wasmann

1913. Ann. Soc. Entom. Belgique, vol. 57, p. 17.

Type: *T. fletcheri* Wasmann

fletcheri Wasmann. India.
Ann. Soc. Entom. Belgique, vol. 57, p. 17. (1913)

Hieronymus Weyenbergh

1886. Tidschr. Ent., vol. 29, p. 133.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 394.

Type: *H. pygmaeus* Weyenb.

pygmaeus Weyenbergh. S. Amer.
Tidschr. Ent., vol. 29, p. 133, fig. (1886)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 394.

Pallura Walker

1859. Journ. Linn. Soc., vol. 3, p. 217.
1901. Becker, Abh. zool.-bot. Ges. Wien, p. 89.
1906. Brues, Genera Ins., fasc. 44, p. 18.
1903. Brues, Trans. Amer. Ent. Soc., vol. 29, p. 394.

Type: *P. invaria* Walk.

invaria Walker.
Journ. Linn. Soc. Zool., vol. 3, p. 127. (1859)
Wulp, Cat. Dipt. South Asia, p. 205. (1896)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 89. (1901)
Brues, Trans. Amer. Ent. Soc., vol. 29, p. 394. (1903)

INCERTAE SEDIS

algira Macq. Algiers.
Dipt. Exot., vol. 3, p. 270, fig. (1843) (*Phora*)
Macquart, Explor. Scient. de l'Algérie, vol. 3, p. 502. (1849) (*Phora*)

anceps Zetterstedt. Sweden.
Dipt. Scand., vol. 7, p. 2888. (1848) (*Trineura*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 74. (1901) (*Phora*) Type not extant.
atra Macquart. France.
Suit. à Buff., vol. 2, p. 629. (1835) (*Phora*)
Meigen, Syst. Beschr., vol. 7, p. 414. (1838) (*Phora*)
Boitard, Nouv. Man. Entom., vol. 3, p. 522. (1843) (*Phora*)
Lioy, Atti Istit. Ven., (3) vol. 10, p. 77. (1864) (*Diploneura*)
bifasciata Walker. Celebes.
Journ. Linn. Soc., vol. 4, p. 172. (1860) (*Phora*)
Wulp, Cat. Dipt. South Asia, p. 205. (1896) (*Phora*)
Brunetti, Rec. Indian Mus., vol. 7, p. 503. (1912) (*Phora*)
This species probably belongs to Dohrniphora.
bovistae Gimmerthal. Livonia, Russia.
Arb. Naturf. Riga, vol. 1, p. 329. (1848) (*Phora*)
carpentieri Gob. France.
Bull. Soc. Linn. Nord France, 1877, p. 202. (*Phora*)
consanguinea Loew. Turkestan.
Schrift. Ges. Freund. Nat. Moscou, 1870, p. 59. (*Phora*)
Osten Sacken, Verh. zool.-bot. Ges. Wien, vol. 32, p. 462. (1884) (*Phora*)
cornuta Bigot.
Sagra's Hist. fis. pol. nat. Cuba, vol. 7, p. 827. (1857) (*Phora*)
dubia Zetterstedt. Sweden.
Dipt. Scand., vol. 7, p. 2888. (1848) (*Trineura*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 74. (1901) (*Phora*) Type not extant.
erythrocera Meigen. Germany.
Syst. Beschr., vol. 6, p. 220. (1830) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 345. (1864) (*Phora*)
Neuhaus, Dipt. March., p. 344. (1886) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 71. (1901) (*Phora*) Type not extant.
festinans Scopoli. Europe.
Entom. Carniol., p. 349. (1763) (*Musca*)
Schiner, Verh. zool.-bot. Ges. Wien, vol. 6, p. 417. (1856) (*Phora*)
fuscipes Macquart. Europe.
Suit. à Buff., vol. 2, p. 627. (1835) (*Phora*)
Meigen, Syst. Beschr., vol. 7, p. 413. (1838) (*Phora*)
Boitard, Nouv. Man. Entom., vol. 3, p. 521. (1843) (*Phora*)
Zetterstedt, Dipt. Scand., vol. 7, p. 2871. (1848) (*Trineura*)
Hardy, Zoologist, 1848, p. 2099. (*Phora*)
Walker, List. Dipt. Brit. Mus., vol. 4, p. 1136. (*Phora*)
Walker, Ins. Brit., vol. 2, p. 280. (1853) (*Phora*)
gracilipes Meigen. Europe.
Syst. Beschr., vol. 6, p. 216. (1830) (*Phora*)
Maerkel, Germ. Zeits. Entom., vol. 5, p. 266. (1845) (*Phora*)

Walker, List. Dipt. Brit. Mus., vol. 4, p. 1136. (1849) (*Phora*)
Walker, Ins. Brit., vol. 2, p. 280. (1853) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 72. (1901) (*Phora*) Type in unrecognizable condition.

hiemalis Rondani. Italy.
Dipt. Ital. Prodr., vol. 1, p. 136. (1856) (*Triphleba*) (sine desc.)

hyalinata Meigen. Germany.
Syst. Beschr., vol. 6, p. 222. (1830) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 71. (1901) (*Phora*) Type not extant.

inclusa Meunier. Fossil; Baltic Amber.
Jahrb. K. Preuss. Geol. Landesanst., vol. 30, p. 82, figs. (1909)

litoralis Dahl. Germany.
SB. Akad. Berlin, 1896, p. 22. (1896) (*Phora*) (sine descr.)

minuta Fabricius.
Syst. Antl., p. 270. (1805) (*Dolichopus*)
Meigen, Syst. Beschr., vol. 4, p. 70. (1824) (*Empis*)
Kowartz, Verh. zool.-bot. Ges. Wien, vol. 27, p. 74. (1877) (*Empis*)
Lundbeck, Dipt. Danica, pt. 3, p. 6 and 189. (1910) (*Phora*)

navigans Frauenfeld. (*Aphiochaeta*?) Brazil.
Verh. zool.-bot. Ges. Wien, vol. 17, p. 454, fig. (1867) (*Phora*)

monochaeta Strobl. Austria.
Wien. Entom. Zeit., vol. 11, p. 202. (1892) (*Phora*)

nebulosa Walker. Tasmania.
Trans. Ent. Soc. London, vol. 4, p. 234. (1857) (*Phora*)

nitidula Meigen. Europe.
Syst. Beschr., vol. 6, p. 221. (1830) (*Phora*)
Macquart, Suit. à Buff., vol. 2, p. 629, fig. (1835) (*Phora*)
Lioy, Atti Istit. Venet., vol. (3) 10, p. 77. (1864) (*Diploneura*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 71. (1901) (*Phora*) Type not extant.

nivalis Rondani. Italy.
Dipt. Ital. Prodr., vol. 1, p. 136. (1886) (*Palpimega*) (*sine descr.*)

nudifrons Macquart. France.
Suit. à Buff., vol. 2, p. 630. (1835) (*Phora*)
Meigen, Syst. Beschr., vol. 7, p. 412. (1838) (*Phora*)
Boitard, Nouv. Man, Entom., vol. 3, p. 522. (1843) (*Phora*)
Lioy, Atti Istit. Venet., vol. (3) 10, p. 79. (1864) (*Lissometopia*)

omnivora Hudson.
Man. New Zealand Entom., p. 62, pl. 7, figs. (1892) (*Phora*)
Hutton, Trans. and Proc. New Zealand Inst., vol. 33. (1900) (*Phora*)

peregrina Wiedemann. Canton.
Aussereur. zweifl. Ins., vol. 2, p. 600. (1830) (*Trineura*)
Wulp, Cat. Dipt. South Asia, p. 205. (1896) (*Phora*)

plurispinosula Zetterstedt. Sweden.
Dipt. Scand., vol. 14, p. 6473. (1860) (*Trineura*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 75. (1901) (*Phora*)

rufipennis Macquart. France.
Suit. à Buff., vol. 2, p. 626. (1835) (*Phora*)
Meigen, Syst. Beschr., vol. 7, p. 413. (1838) (*Phora*)
Lioy, Atti Istit. Venet., vol. (3) 10, p. 77. (1864) (*Obelosia*)
rapida Meigen. Germany.
Syst. Beschr., vol. 7, p. 412. (1838) (*Phora*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 72. (1901) (*Phora*)
quadrata Gimmerthal. Russia.
Bull. Soc. Imp. Nat. Moscow., vol. 14, p. 686. (1842) (*Phora*)
scapularis Macquart. France.
Suit. à Buff., vol. 2, p. 626. (1835) (*Phora*)
Meigen, Syst. Beschr., vol. 7, p. 413. (1838) (*Phora*)
Boitard, Nouv. Man. Entom., vol. 3, p. 521. (1843) (*Phora*)
semiflava Hartig. Germany.
Jahrsb. ub. d. Fortschr. d. Forstw., vol. 1, p. 305. (1837) (*Phora*)
Ratzeburg, Forstinsekten, vol. 3, p. 176. (1844) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 345. (1864) (*Phora*)
setigera Loew. Russia.
Zeits. Ges. Naturwiss., vol. 43, p. 420. (1874) (*Phora*)
sphingicides Bouché. Germany.
Naturgesch. d. Ins., p. 101. (1834) (*Phora*)
Schiner, Faun. Austr., vol. 2, p. 345. (1864) (*Phora*)
Westwood, Introd. Mod. Class. Ins., vol. 2, p. 575. (1845) (*Phora sphingidis*)
sphingidis Westwood. = *sphingicides* Bouché.
Introd. Mod. Class. Ins., vol. 2, p. 575. (1845) (*Phora*)
subquadrifasciata Zetterstedt. Sweden.
Dipt. Scand., vol. 12, p. 4826. (1855) (*Trineura*)
Becker, Abh. zool.-bot. Ges. Wien, vol. 1, p. 75. (1901) (*Phora*) Type not extant.
tubericola Schiner. Austria.
Verh. zool.-bot. Ges. Wien, vol. 16, p. 972, fig. (1866) (*Phora*)
vicina Macquart. France.
Suit. à Buff., vol. 2, p. 627. (1835) (*Phora*)
Meigen, Syst. Beschr., vol. 7, p. 413. (1838) (*Phora*)
Boitard, Nouv. Man. Entom., vol. 3, p. 521. (1843) (*Phora*)
villosa Macquart. Algeria.
Dipt. Exot., vol. 3, p. 428. (1843) (*Phora*)
Macquart, Explor. Scient. d'Algérie, vol. 3, p. 502. (1849)
Phora sp. Meunier. Fossil; Madagascar Copal.
Misc. Entom., vol. 13, p. 6, fig. (1905)

THE AMERICAN SPECIES OF MYRMICA ALLIED TO M. *RUBIDA* LATREILLE

By WILLIAM MORTON WHEELER

[Reprinted from PSYCHE, Vol. XXI, No. 4]

THE AMERICAN SPECIES OF MYRMICA ALLIED TO *M. RUBIDA* LATREILLE.[1]

By William Morton Wheeler.

The large and handsome *Myrmica rubida* Latreille remained for many years the only species of an aberrant group within its genus. In 1894 Emery described the first American species of this group, *M. mutica*, from Denver, Colo., and five years ago I added a species from California, *M. bradleyi*. Two additional species, *M. aldrichi* and *hunteri*, from Idaho and Montana respectively, have since come to light and are described in the following pages. Thus all of the American forms are known only from the mountainous regions of the Western States. The single Old World species occurs in similar localities in Central and Southern Europe and as far east as the Caucasus in Asia Minor and Eastern Siberia. I have had abundant opportunity to study *M. rubida* in the Rhone valley and other localities in Switzerland and *M. mutica* at Colorado Springs and in neighboring localities in Colorado. Both species have very similar habits. They usually nest in sandy creek bottoms under stones or in small crater nests. The workers of both species sting severely, especially the Eurasian *M. rubida*, but neither is very aggressive. The pupæ have a peculiar canary yellow color, unlike that of any other species of the genus.

As all five of the species now recognized are closely related to one another and constitute a sharply defined group, I propose to separate them from *Myrmica sens. str.* as a subgenus, *Oreomyrma, subgen. nov.*, with *M. rubida* Latr. as the type (Fig. 1a). The workers and females in this subgenus are distinguished by having the epinotum unarmed, the antennal club 5-jointed and the mandibles with two large apical and 12–14 minute basal teeth. The male has no club to the antennal funiculi and the mandibles are like those of the worker. In *Myrmica sens. str.*, with the type *M. rubra* L., the antennal club of the worker and female is 3-or 4-jointed, the mandibles have only 7–12 teeth and the epinotum is armed with a pair of spines. The males have a distinct 4- or 5-jointed antennal club, and their mandibles are only 4–8-toothed.

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 79.

The males and females of only two of the species (*M. rubida* and *mutica*) are known. The workers of the five species may be readily separated by means of the following key:

1. Anteroventral surface of postpetiole with a pointed or rounded tubercle or protuberance 2
   Anteroventral surface of postpetiole flat or at any rate without a tubercle or protuberance 3
2. Large species (worker, 7–8.5 mm.; female, 9.5–12 mm., male, 8.5–10 mm.) epinotum subdentate; postpetiole with a small, pointed, anteroventral tubercle; deep red, posterior portion of first gastric segment blackish *rubida* Latreille.
   Smaller species (worker, 4–6 mm.), anterior border of clypeus entire, epinotum not subdentate, rounded in profile; anteroventral portion of postpetiole much more protuberant 4
3. Deep red; petiole subopaque ..... *mutica* Emery.
   Black, with red thorax, petiole and postpetiole; both petiole and postpetiole shining, more slender ..... *bradleyi* Wheeler.
4. Yellow; anteroventral tubercle of postpetiole conical or pointed. *aldrichi* sp. nov.
   Deep red; spot on vertex and posterior portion of first gastric segment black; anteroventral tubercle of postpetiole more rounded ..... *hunteri* sp. nov.

Myrmica (Oreomyrma) mutica Emery (Fig. 1 d).

Myrmica mutica Emery, Zoöl. Jahrb. Abth. f. Syst. VIII, 1894, p. 311 ♀.

Worker: Length, 4–6 mm.

Head subrectangular, as broad as long, with straight lateral borders and rounded posterior corners. Eyes at the middle of the sides. Clypeus convex, its anterior border very feebly sinuate in the middle. Mandibles with two large apical and about a dozen minute basal teeth. Antennal scapes, rather strongly curved and slightly flattened at the base, scarcely reaching beyond the posterior corners of the head. Funicular club 5-jointed. Thorax in profile with rounded pronotum and the mesonotum gently sloping to a rather deep constriction in front of the epinotum, which has a subequal base and declivity, the former feebly convex, the latter sloping and nearly straight. Petiole in profile longer than high, its node bluntly rounded, with concave anterior and convex posterior slopes; ventral surface of peduncle in front with a small, acute tooth. Postpetiole scarcely longer than broad, a little broader behind than in front, somewhat broader than the petiole; its ventral surface in profile straight. Gaster a little larger than the head. Legs long, tibiæ and femora feebly clavate.

Subopaque; dental border of mandibles, postpetiole, gaster and legs shining. Mandibles, frontal area and front longitudinally rugose; remainder of the head longitudinally and rather indistinctly punctate-rugulose. Thorax finely rugose, longitudinally on the pleuræ, pro- and mesonotum, transversely and more coarsely on the epinotum. Petiole and ventral portion of postpetiole finely and densely punctate. Gaster and legs with small, scattered, piligerous punctures.

Hairs white, erect or suberect, coarse, rather short, abundant on all parts of the body, legs and scapes.

Ferruginous red; gaster slightly paler; frontal area, and in some specimens also the antennal clubs, infuscated; mandibular teeth black.

Female: Length, 6.5–7.5 mm.

Closely resembling the worker. Postpetiole in some specimens opaque rugulose, or with only the node smooth and shining. Mesonotum and scutellum sharply and regularly longitudinally rugose, the former with an anteromedian and a pair of parapsidal blackish streaks. Wings grayish hyaline; veins pale brown, stigma dark brown.

Male: Length, 6–7 mm.

Head, including the eyes and excluding the mandibles, distinctly broader than long, rounded behind. Mandibles similar to those of the worker, with two large apical and numerous minute basal teeth. Clypeus very convex, with entire anterior border. Antennæ slender; scapes very short, not longer than the second funicular joint; which is three times as long as the first and of the same length as the succeeding joints. There is no differentiated club. Thorax rather small, narrower than the head through the eyes, with very distinct Mayrian furrows. Scutellum convex, epinotum, petiole and postpetiole much as in the worker. Gaster more slender, with the genital appendages proportionally larger and more exserted than in *M. rubida.*

Shining; head opaque, indistinctly punctate and longitudinally rugulose; thorax subopaque, more shining above, longitudinally rugose-punctate even on the epinotum. Sides and ventral portions of petiole finely and densely punctate.

Hairs much as in the worker but more delicate and flexuous.

Black; dental borders of mandibles, tibiæ and tarsi brown or sordid yellowish; gaster red, often brownish in the middle above; base of first segment sometimes black or all of the gaster, except the base of the first segment, black. In other specimens the postpetiole is red. Wings colored as in the female.

Colorado: Denver; type locality (Theo. Pergande); Colorado Springs, Salida, Buena Vista and Wild Horse, 6000-7000 ft. (Wheeler); Canyon City (Rev. P. J. Schmitt).

New Mexico: (Ern. André.).

Utah: Salt Lake County (R. V. Chamberlin), as the host of the peculiar xenobiotic ant, *Symmyrmica chamberlini* Wheeler.

Washington: Olympia (T. Kincaid); Ellensburg and Pullman (W. M. Mann).

Alberta: McLeod (C. G. Hewitt).

British Columbia: Dog Lake, Penticton (C. G. Hewitt).

Myrmica (Oreomyrma) bradleyi Wheeler. (Fig. 1 c.)

Myrmica bradleyi Wheeler, Journ. N. Y. Ent. Soc. XVII, 1909, p. 77, ♀.

Myrmica (Oreomyrma) aldrichi sp. nov. (Fig. 1 b.)

Worker: Length 5–6 mm.

Head subrectangular, a little longer than broad, with nearly straight sides and posterior border and rounded posterior corners. Mandibles and antennæ as in

M. mutica. Clypeus convex, its anterior border very feebly sinuate in the middle. Frontal area indistinct. Thorax similar to that of *mutica*, but the epinotum with its base feebly and evenly convex and fully twice as long as the distinctly concave declivity. Petiole laterally compressed ventrally, with a small, acute tooth near the anterior end of the peduncle, its node from above subelliptical, longer than broad, in profile with concave anterior and slightly convex posterior slopes. Postpetiole from above but little broader than the petiole, slightly longer than broad, a little broader behind than in front; in profile convex above, especially behind, below with a prominent conical or pointed protuberance near its anterior end.

Mandibles opaque, finely longitudinally striated, their dental border smooth and shining. Head and thorax opaque, longitudinally rugulose-punctate, posterior portion of clypeus, vertex, occiput and pronotum above smooth and shining. Epinotum transversely rugulose. Gaster, legs, petiolar and postpetiolar nodes smooth and shining, with sparse, minute, piligerous punctures; petiole and postpetiole on the sides and below subopaque; finely and densely punctate.

Hairs white, erect, rather short; covering the body, legs and scapes as in *M. mutica.*

Brownish yellow; dental borders of mandibles and antennal clubs pale brown.

Described from sixteen specimens taken by Prof. J. M. Aldrich at Moscow, Idaho.

At first sight this species may be readily mistaken for an immature *M. mutica* on account of its yellow color, but on closer inspection it is easily distinguished by the shape of the epinotum and postpetiole and the smooth front, occiput, pronotum and petiolar mode.

Myrmica (Oreomyrma) hunteri sp. nov. (Fig. 1 c).

Worker: Length 4–6 mm.

Closely related to *M. aldrichi* but differing in the following characters: Body and appendages brownish red or ferruginous, with a large, black, subtriangular spot on the vertex and a band of the same color across the posterior portion of the first gastric segment. Frontal area, posterior clypeal suture, antennal clubs and dental border of mandibles more or less infuscated. Sculpture sharper and coarser than in *aldrichi.* Upper surface of head with coarse, scattered punctures in addition to the rugæ. Smooth areas on the head, thorax and pedicel much as in that species. Hairs pale yellow instead of white. Anterior clypeal border entire. Base of epinotum somewhat flattened, anteroventral protuberance of postpetiole broadly rounded and not conical or pointed.

Described from a dozen specimens taken by Dr. S. J. Hunter from a couple of nests on the slopes of two mountains on the Madison River, nearly opposite the mouth of Beaver Creek, Montana, at an altitude of about 7,500 feet. The nests were in shaley earth and apparently of the crater type.

Of all the American species of *Oreomryma, hunteri* is most closely related to the palearctic *rubida* in coloration and sculpture. Per-

haps it should be regarded merely as a subspecies of *aldrichi*, but its exact status can be determined only with the aid of additional material and with specimens of the males and females of both forms.

Further researches in the mountains of the northwest will probably bring to light additional species of *Oreomyrma*. The number and distribution of those at present known indicate that the Rocky Mountains are the center of distribution of the subgenus and that *M. rubida* may have reached the Old World during the Tertiary by way of the Behring Strait land-bridge.

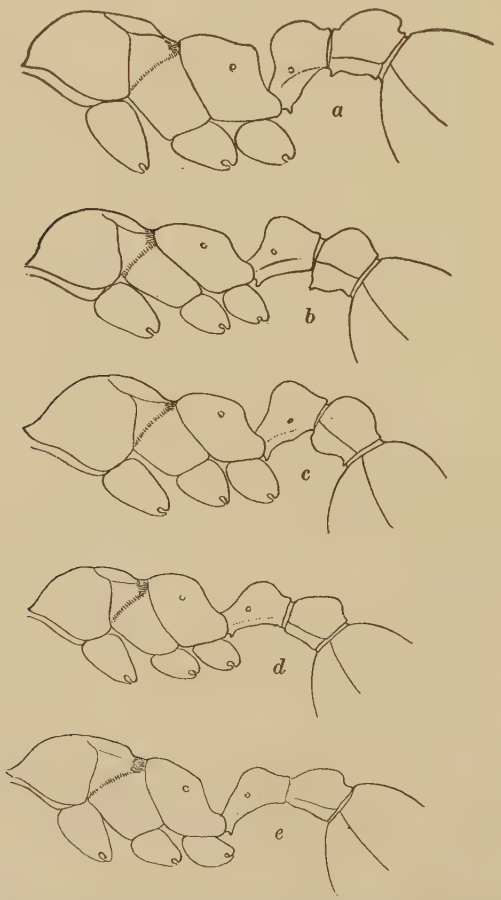

Fig. 1. *a*, Thorax and pedicel of *Myrmica* (*Oreomyrma*) *rubida* Latr. in profile; *b*, of *M.* (*O.*) *aldrichi* sp. nov.; *c*, of *M.* (*O.*) *hunteri* sp. nov.; *d*, of *M.* (*O.*) *mutica* Emery; *e*, of *M.* (*O.*) *bradleyi* Wheeler.

[Reprinted from Psyche, Vol. XXI, No. 5]

NEW AND LITTLE KNOWN HARVESTING ANTS OF THE GENUS POGONOMYRMEX.[1]

By William Morton Wheeler.

1. Pogonomyrmex guatemaltecus sp. nov.

Worker. Length 5–5.5 mm.

Head subrectangular, excluding the mandibles a little longer than broad, with nearly straight sides, feebly excised posterior margin and prominent anterior cor-

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 80.

ners. Eyes rather small and flat, elliptical, just in front of the median transverse diameter of the head. Mandibles convex, with five subequal teeth. Clypeus short, feebly convex, its anterior border strongly bidentate, arcuately excised between the teeth, sinuate laterally. Frontal area distinct, with a median carinula. Antennal scapes reaching less than half the distance between the eyes and posterior corners of the head; funicular joints 2–10 scarcely longer than broad. Thorax short, but little longer than the head without the mandibles, broadest through the pronotum, somewhat compressed behind; in profile the dorsal outline is usually convex and evenly rounded as far back as the boundary between the epinotal base and declivity. These meet at an obtuse angle, the declivity being shorter than the base, descending perpendicularly and forming a right angle on each side with the metasternal angle which is sharp and rectangular in profile. There are no traces of spines or teeth on the epinotum. Petiole with a slender, laterally compressed peduncle which is nearly as long as the node and armed with a distinct anteroventral tooth; node compressed anteroposteriorly and rounded in front, slightly overarching the peduncle, with which its straight or slightly concave anterior surface forms at least a right angle and in some specimens even an acute angle in profile; seen from above the posterior surface is subelliptical, nearly twice as long as broad, and with rounded and not acute anterior border. Postpetiole campanulate, a little broader than the petiole, broader behind than in front, in profile very convex both dorsally and ventrally. Gaster elliptical, smaller than the head. Legs well developed.

Body, but especially the mandibles and gaster, shining. Mandibles very coarsely longitudinally striated. Clypeus and head covered with coarse longitudinal rugæ, subparallel on the head and diverging only very slightly from the median line and not till they reach the occiput. Interrugal spaces reticulate and feebly punctate. Anterior depressed portion of pronotum transversely rugulose; remainder of pronotum, the mesonotum and pleuræ coarsely and longitudinally reticulate-rugose. Rugæ on the epinotum finer and transverse. Petiolar peduncle smooth and shining, posterior surface of node coarsely longitudinally reticulate-rugose. Postpetiole subopaque, finely and densely reticulate-punctate. Upper surface of gaster with sparse piligerous foveolæ, which are somewhat more closely aggregated near the anterior margin of the first segment. Legs very finely shagreened with small, sparse, piligerous punctures. Antennal scapes longitudinally rugulose.

Hairs pale yellow, stiff, pointed, erect, varying in length, generally distributed over the body and appendages. Ammochætæ on clypeus, ventral surfaces of mandibles and gula long, but on the gula forming only a small psammophore, *i.e.*, the long hairs surround only the anterior portion of the gula and do not enclose the whole of it as in most species of *Pogonomyrmex sens. str.*

Color deep red, legs and base of first gastric segment slightly paler; teeth of mandibles black; anterior border of clypeus, posterior border of first gastric segment and a transverse band on each of the remaining segments dark brown or blackish.

Female (deälated). Length nearly 7 mm.

Very similar to the worker. Rugosity of thorax finer and more regular. Gaster larger, with the black banding of the segments more distinct, but the punctures on the dorsal surface smaller and less foveolate.

Described from a large number of workers and a single female, which I took December 12–14, 1911, from many nests at Zacapa, Guatemala, in the extremely arid plains known as "La Fragua," a region with pronounced xerophytic vegetation (giant cacti, etc). The ants were nesting in the fields, the grass of which, at the time of my visit, was parched and had been eaten down to the roots by the cattle. The nests were regular, flattened craters from 3–8 inches in diameter, not surrounded by clearings, and much like the nests of the other small North American species of *Pogonomyrmex*. A pile of grass-seed or chaff, often found to one side of the crater, showed that the species is granivorous like other members of the genus. Many nests were also found in the sand-ballast of the railroad near the town of Zacapa. The worker is readily distinguished from that of most of the described species of *Pogonomyrmex* by the peculiar shape of the thorax, clypeus and petiole and by the 5-toothed mandibles.

2. **Pogonomyrmex huachucanus** sp. nov.

Worker. Length 4.5–5 mm.

Head subrectangular, excluding the mandibles as broad as long, with nearly straight lateral and feebly excised posterior margin. Eyes elliptical, rather convex, at the middle of the sides of the head. Mandibles with convex external and rather oblique apical borders, the latter 6-toothed. Clypeus moderately convex, its anterior border marginate, distinctly bidentate and arcuately excised between the teeth. Frontal area distinct, with median carinula. Antennæ not reaching halfway between the eyes and the posterior corners of the head; first and second funicular joints distinctly longer than broad, remaining joints, except the last, as long as broad. Thorax slightly longer than the head without the mandibles, from above broadest through the pronotum, but with the transverse diameters of the meso- and epinotum equal; in profile the dorsal outline is convex in the pronotal region but the mesonotum and base of the epinotum form a straight line gently sloping to the two spines, which are shorter than the base of the epinotum, rather slender but blunt, closely approximated at their bases and directed upward, outward and slightly backward. The epinotal declivity is short, abrupt and much as in *P. guatemaltecus*, forming in profile a right angle with the metasternal angles, which are in turn rectangular. Petiole with slender, laterally much compressed peduncle, half as long as the node and with a distinct but rather blunt anteroventral tooth. Node from above subelliptical, pointed or acuminate in front, less than twice as long as broad, its posterior surface rather sharply marked off from the anterior, so that the summit appears pointed also in profile. The anterior surface is slightly convex in profile and rises abruptly and perpendicularly from the peduncle, the posterior surface, also slightly convex, is about one and one half times as long as the anterior and constricted near its posterior end. Postpetiole from above sub-

globular, a little broader behind than in front, a little broader than long and somewhat broader than the petiolar node. In profile the dorsal surface is very convex, the ventral bears a rounded boss in its middle. Gaster elliptical, proportionally larger than in *P. guatemaltecus*

Mandibles, gaster and legs shining, remainder of body appearing more subopaque, owing to their sculpture. Mandibles longitudinally striated; clypeus and head longitudinally rugose, the rugæ being moderately strong and numerous and distinctly and gradually diverging from the median line towards the posterior corners; the interrugal spaces densely punctate. Thorax throughout reticulately rugose, the rugæ being somewhat coarser and further apart than on the head, longitudinal on the pronotum and pleuræ and arcuately transverse on the mesonotum and base of the epinotum. Peduncle and anterior surface of petiolar node shining, finely shagreened, posterior surface coarsely and irregularly rugose and punctate. Postpetiole finely and densely punctate. Gaster very smooth and shining even at the base, with minute and sparse piligerous punctures. Legs finely shagreened and sparsely punctate, antennal scapes longitudinally rugulose.

Hairs pale yellow, erect, of unequal length, covering all parts of the body, longest on the dorsal surface. Ammochætæ well-developed on the clypeus, ventral surfaces of mandibles and gula, but the psammophore is restricted as in *P. guatemaltecus* and does not extend to the posterior and lateral borders of the head.

Deep red, lower surface of head, the legs, coxæ and gaster paler and more yellowish; dorsal surface of first gastric segment with a dark brown cloud on each side and usually with a median longitudinal streak of the same color. Mandibular teeth and anterior border of clypeus black.

Described from twenty-two specimens taken by myself November 11, 1910, from a single nest on the rocky southern wall of Miller Canyon in the Huachuca Mountains, Arizona, at an altitude of about 5,600 feet. This nest was under a small, flat stone and resembled the nests of *P.* (*Ephebomyrmex*) *imberbiculus* Wheeler, which I have seen in the mountains of Texas.

At first sight *P. huachucanus* resembles *guatemaltecus*, but closer comparison reveals many differences, especially in the shape of the thorax and petiole, not the least being the presence of epinotal spines in the former species. This is, indeed, unlike any of the known North American species but singularly close to *P. bispinosus* Spinola of Chili, as I find by comparison with cotypes of the variety *semistriatus* Emery received from Professor Silvestri. The thorax in *bispinosus*, however, is more flattened dorsally in front than in *huachucanus*, the metasternal angles are rounder, the petiolar node is lower and the postpetiole is as long as broad and less globular. The gaster of the typical *bispinosus* is said to be smooth and shining as in *huachucanus*, but in the variety *semistriatus* its

base is opaque and finely punctate-striolate. These differences are all so slight that *huachucanus* may eventually prove to be merely a subspecies of *bispinosus*. The resemblances between the two forms, separated by such a wide territory, is very suggestive in connection with the origin of the genus *Pogonomyrmex*. Owing to the fact that this genus is represented by the greatest number of species in North America, and that it is most closely related to the boreal genus *Myrmica*, it has been assumed that the species of *Pogonomyrmex* originated in the western United States and migrated thence along the arid plains and mountain ranges through Mexico, Central and South America as far as Patagonia. On this assumption, *P. huachucanus* might be regarded as a rare relict of a group of species which once ranged over a large portion of western America, but now survive only in Chili and the Huachuca Mountains of Arizona.

P. huachucanus and *guatemaltecus*, together with *bispinosus* and two other South American species, *brevibarbis* Emery and *silvestrii* Emery, are also of considerable interest, because in the restricted area of the gula enclosed by the long hairs of the psammophore and in sculpture they are transitional between the species of *Pogonomyrmex sens. str.* and the subgenus *Ephebomyrmex* Wheeler. The acute, spinose character of the metasternal angles in *brevibarbis* and *silvestrii* reveals a still closer relationship to the latter subgenus. All of these species may, therefore, represent today the most primitive and ancestral forms from which both subgenera have been evolved.

3. **Pogonomyrmex californicus** Buckley.

The worker of the typical form of this species measures 5.5–6 mm. and is characterized by the shape of the petiole and the sculpture. The anterior surface of the petiolar node forms very nearly a right angle with the upper surface of the peduncle, and the ventral surface of the latter bears no tooth. The surface of the body is shining, the rugæ of the head and thorax being sharp and pronounced, the spaces between them impunctate or with punctures so small and shallow as to be barely visible under a magnification of 20 diameters. The petiolar and post-petiolar nodes are very finely and densely punctate and indistinctly rugulose. The body is light ferruginous red, the mandibles, clypeus and legs more yellowish.

The female measures about 8 mm. and resembles the worker very closely in form, sculpture and color. The head is somewhat broader than long. Wings hyaline, with their basal portions distinctly yellowish, the veins and stigma brown.

The male measures 7.5 mm. and has rather broad mandibles, with oblique 4-toothed blades. Head, thorax, nodes of petiole and postpetiole, coxæ and femora,

except their bases and tips, and base of first gastric segment, black; remainder of body red, the mandibles and antennæ being more brownish, the gaster more yellowish in tint. Wings colored as in the female.

No type-locality in California is mentioned in Buckley's original description. I have seen numerous specimens from the following places:

California: Lakeside, Pasadena and Claremont (Wheeler); Point Loma, near San Diego (P. Leonard); San Pedro (T. D. A. Cockerell); Lompoc and Upland (J. C. Bradley); San Jacinto; Sierra Valley.

Arizona: Yuma (Wheeler).

Nevada: Las Vegas (J. C. Bradley)

This ant is very common in the sandy canyon bottoms of southern California. Its nests are flat craters 4–10 inches in diameter, with sloping, central or eccentric entrances. The workers are agile hunters of insects when these are to be found, but at certain seasons of the year large numbers of seeds are collected and stored in the nests. The nests in the Arroyo Seco, at Pasadena, Cal., were often found covered with the seeds of a common canyon shrub (*Eriogonum fasciculatum*) during the month of December.

4. **Pogonomyrmex californicus** Buckley, subsp. **estebanius** Pergande.

This form, which should be regarded as a subspecies and not as a variety, averages a little smaller in all three phases than the typical *californicus*. In the worker the rugæ of the head and thorax are decidedly more delicate, but the interrugal punctures are quite as indistinct. The anterior surface of the petiolar node is more sloping and therefore forms a larger obtuse angle with the upper surface of the peduncle, and the node is lower than in the typical form of the species. There is also a tendency to develop a tooth on the anteroventral surface of the petiole. Typically the gaster is black, with the base of the first segment yellowish red; but specimens are sometimes found with only the tip of the gaster black or with a few black spots on the first segment, usually near its lateral or posterior borders. The nodes are sometimes infuscated; more rarely the whole gaster is black.

The female varies considerably in size, from 7–9 mm; and the gaster varies greatly in color. In most of my specimens it is entirely black, except for a large, bilobed, yellowish red spot at the base of the first segment. In others only the lateral and posterior margins of this segment are black and often the markings are interrupted in the middorsal line. The veins of the wings are pale yellow, but the stigma is brown.

The male measures 6.5–8.5 mm. Its mandibles are narrow, with transverse, bidentate, apical borders. Its color resembles that of the typical *californicus*, except that the gaster is in some specimens entirely red, in others entirely black. In some specimens, too, more or less of the anterior portion of the head may be red.

Lower California: Calmalli Mines, San Esteban, type locality; San Borgia and Margarita Island (Eisen and Haines).

California: Needles (Wheeler); Otis (J. C. Bradley).

Arizona: Yuma, Yucca, Tucson and Phoenix (Wheeler); Nogales (Oslar); Florence.

This subspecies is very abundant in the hot deserts of California and Arizona, but according to my observations it nests only in pure sand.

5. **Pogonomyrmex californicus** Buckley subsp. **longinodis** Emery.

I fail to find this form among the large amount of material I have collected, and am inclined to believe that it must be either very rare or local. It was described by Emery as follows from specimens taken in the Colorado Desert of California and received from Pergande: "The worker differs from that of *P. californicus* in its more slender pedicel, the second joint of which [*i.e.* the postpetiole] is not as high as long; the peduncle of the first joint [petiole] is shorter than the very long and anteriorly pointed node. Sculpture feebler than in *californicus;* pedicel merely finely punctate, without rugæ. Color rather light red, abdomen, with the exception of the pedicel and its base, brown."

6. **Pogonomyrmex californicus** Buckley subsp. **maricopa** subsp. nov.

The worker of this form measures 6–7.5 mm. and therefore averages larger than the typical *californicus* from which it differs in the shape of the petiole and in sculpture. The node of the petiole is less pointed above, its anterior surface is straight and forms an obtuse angle with the upper surface of the peduncle, and there is often a distinct anteroventral tooth. The petiole is fully as long as high. The rugæ of the head and thorax are much less prominent and the spaces between them are filled densely with very distinct punctures, clearly visible under a magnification of 20 diameters. The surface of the head and thorax are decidedly subopaque and not shining as in the typical *californicus*. The nodes of the petiole and postpetiole are also more coarsely shagreened and less shining. The color is the same.

A single deälated female from Rincon, New Mexico, measures 8 mm. and closely resembles the female of the typical form in sculpture, the rugæ of the head and thorax being sharp, the interrugal punctures rather indistinct.

New Mexico: Alamogordo, type locality (G. von Krockow); Prescott and Albuquerque (Wheeler); Roswell, Deming and El Rincon (T. D. A. Cockerell); Las Truches (Miss Lillie Gerhardt); Engle (Miss Nora Newberry.)

Arizona: Yuma, Tucson, Benson and Grand Canyon (Wheeler).

California: Needles (Wheeler).

Texas: Marfa (Wheeler); Barton (J. C. Crawford); Victoria (J. D. Mitchell); Chisos Mts., 4600 ft. (W. B. Phillips).

Mexico: Ojos del Diablo and Ojos de San Dijuela in Chihuahua (C. H. T. Townsend).

As shown by this list of localities, *maricopa* ranges much further

to the east, through the deserts of New Mexico and Texas, than the other subspecies of *californicus*, and usually occurs at greater elevations. Its nests are very similar, being flat craters in sand, with sloping central or eccentric entrances.

7. **Pogonomyrmex subnitidus** Emery.

If I am correct in my identification, this form is not a subspecies of *P. occidentalis* Cresson, as Emery supposed, but a distinct species. Emery's description is unfortunately very brief, but I believe that it refers to a form which I found nesting in the vicinity of Pasadena, California, both in the higher portions of the Arroyo Seco and on the summit of Mt. Lowe (6400 ft.). I have also received a series of workers of the same form from Mr. J. C. Bradley, who took them in Los Gatos Canyon of the Diablo Range in the same state. The nests are like those of *californicus* and therefore entirely unlike the nests of *occidentalis*. The sculpture of the head, thorax and pedicel of the worker, moreover, is very much like that of the true *californicus*, but the epinotum is armed with two slender, pointed spines, which are longer than in *occidentalis*.

8. **Pogonomyrmex comanche** Wheeler.

This form, which was also originally described as a subspecies of *occidentalis*, must now be regarded as an independent species. In the worker *comanche* the thoracic dorsum is distinctly more rounded and arched in profile than in the worker *occidentalis* and the epinotal spines are longer both in the worker and female, but especially in the latter. There is also a great difference in the mandibles of the males of the two species, the blade in the male *occidentalis* being moderately broad with oblique apical border bearing 5 or 6 teeth, whereas in *comanche* it is narrow and more curved and its apical border is transverse and only 3–4-toothed. The epinotum of the male *comanche* bears a pair of small teeth, which are represented by tubercles in *occidentalis*. The greatest difference between the two species, however, is seen in the habits and distribution, *comanche* living at low levels in pure sand, where it makes rather small, flat crater nests very much like those of *californicus*, whereas *occidentalis* lives at elevations over 6,000 feet, and constructs large gravel cones with basal entrance and surrounded by a clearing. The colonies of the latter species are also much more populous. The types of *comanche* were taken in the

sandy post oak woods at Montopolis, near Austin, Texas. I have taken the species also at Milano in the same state.

A study of *comanche*, *subnitidus*, *californicus* and its subspecies *maricopa* shows that these forms have essentially the same habits and are all very closely and peculiarly related. Without its spines the worker *subnitidus* would be indistinguishable from the worker *californicus*, and the same relation obtains between *comanche* and *maricopa*. As it seems evident that the spined species of *Pogonomyrmex* must be more primitive that the spineless forms, it is not improbable that *subnitidus* is really the parent species of *californicus* and *comanche* the parent species of *maricopa*. If further study supports this conclusion, *maricopa* will have to be regarded as a distinct species.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LVIII. No. 9.

A NEW PERIPATUS FROM COLOMBIA.

By Charles T. Brues.

With Two Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
September, 1914.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUTENANT COMMANDER L. M. GARRETT, U. S. N., COMMANDING, PUBLISHED OR IN PREPARATION:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
H. B. BIGELOW. XXIII.[23] The Siphonophores.
H. B. BIGELOW. XXVI.[26] The Ctenophores.
R. P. BIGELOW. The Stomatopods.
O. CARLGREN. The Actinaria.
R. V. CHAMBERLIN. The Annelids.
S. F. CLARKE. VIII.[8] The Hydroids.
W. R. COE. The Nemerteans.
L. J. COLE. XIX.[19] The Pycnogonida.
W. H. DALL. XIV.[14] The Mollusks.
C. R. EASTMAN. VII.[7] The Sharks' Teeth.
S. GARMAN. XII.[12] The Reptiles.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. XXVII.[27] The Schizopods.
S. HENSHAW. The Insects.
W. E. HOYLE. The Cephalopods.
W. C. KENDALL and L. RADCLIFFE. XXV.[25]. The Fishes.
C. A. KOFOID. III.[3] IX.[9] XX.[20] The Protozoa.
C. A. KOFOID and J. R. MICHENER. XXII.[22] The Protozoa.
C. A. KOFOID and E. J. RIGDEN. XXIV.[24] The Protozoa.
P. KRUMBACH. The Sagittae.
R. VON LENDENFELD. XXI.[21] The Siliceous Sponges.
—— The Holothurians.
—— The Starfishes.
—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
JOHN MURRAY and G. V. LEE. XVII.[17] The Bottom Specimens.
MARY J. RATHBUN. X.[10] The Crustacea Decapoda.
HARRIET RICHARDSON. II.[2] The Isopods.
W. E. RITTER. IV.[4] The Tunicates.
B. L. ROBINSON. The Plants.
G. O. SARS. The Copepods.
F. E. SCHULZE. XI.[11] The Xenophyophoras.
HARRIET R. SEARLE. XXVIII.[28] Isopods.
H. R. SIMROTH. Pteropods, Heteropods.
E. C. STARKS. XIII.[13] Atelaxia.
TH. STUDER. The Alcyonaria.
JH. THIELE. XV.[15] Bathysciadium.
T. W. VAUGHAN. VI.[6] The Corals.
R. WOLTERECK. XVIII.[18] The Amphipods.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.
[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
[7] Bull. M. C. Z., Vol. L., No. 4, November, 1906, 26 pp., 4 pls.
[8] Mem. M. C. Z., Vol. XXXV., No. 1, February, 1907, 20 pp., 15 pls.
[9] Bull. M. C. Z., Vol. L., No. 6, February, 1907, 48 pp., 18 pls.
[10] Mem. M. C. Z., Vol. XXXV, No. 2, August, 1907, 56 pp., 9 pls.
[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls.
[15] Bull. M. C. Z., Vol. LII., No. 5, October, 1908, 11 pp., 2 pls.
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps.
[18] Bull. M. C. Z., Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909, 10 pp., 3 pls.
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
[21] Mem. M. C. Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem. M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls.
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV, No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem. M. C. Z., Vol. XXXV., No. 4, July, 1912, 124 pp., 12 pls.
[28] Bull. M. C. Z., Vol. LVIII., No. 8, August, 1914, 14 pp.

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September, 1914.

No. 9.— *A New Peripatus from Colombia.*[1]

By Charles T. Brues.

The Bryant Walker Expedition, of the University of Michigan, which visited the Sierra Nevada de Santa Marta in northeastern Colombia during the summer of 1913, obtained an interesting series of Onychophora. Through the kindness of Dr. A. G. Ruthven, the leader of the Expedition, I have had the opportunity of examining these specimens which were collected by himself and Prof. A. S. Pearse. Professor Pearse made some valuable field notes at the time the animals were obtained, and these are of such interest, that they are included separately at the end of the taxonomic account.

Three species are represented in the collection, *P. edwardsii* and *P. imthurmi* in addition to the one described as new. All belong to Bouvier's (Monographie des onychophores, 1907, p. 158) group of "Péripates caraïbes" which has lately been given the subgeneric name of Epiperipatus by Clark (Proc. Biol. soc. Washington, 1913, **26**, p. 17). It may be mentioned, however, that Bouvier's division of the neotropical forms into Andicolous and Caribbean species does not hold for the Colombian species as has recently been shown by Fuhrmann (Zool. anz., 1913, **42**, p. 242).

Peripatus (Epiperipatus) vespucci, sp. nov.

Plate **1**, fig. 1–4; Plate **2**, fig. 7.

A small, moderately slender species with 33 or 34 pairs of legs in the female and 30 pairs in the male. Integument similar to that of *P. brasiliensis*, but there are two incomplete folds on each body segment.

Form and dimensions. Body rather slender, considerably narrowed at each end, so that it tapers very decidedly from a broadened middle portion toward the head and posterior end. In the three specimens before me, the body measurements are as follows:—

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 81.

TABLE 1.

Length of body	Greatest breadth	Number of legs
Type ♀ 32 mm.	5 mm.	34 pairs
Paratype ♀ 36 mm.	5 mm.	33 pairs
Paratype ♂ 21 mm.	4 mm.	30 pairs

Although there is a difference in proportions in the two females the paratype is more fully expanded and consequently appears to be of a more slender form. The type female and the male are of very similar shape (see Plate **2**, fig. 11).

Coloration. All three specimens are considerably decolorized from their preservation in alcohol, but still show very distinctly the general color-pattern of the body. To the naked eye, the legs and a broad stripe directly above them are much lighter than the dorsal region, exhibiting a dull yellowish gray tint with distinct purplish cast which is much more distinct in one specimen. In all three, the legs are decidedly paler than the pleural stripe. The dorsal region, including two thirds of the animal when seen from above, is much darker than the pleurae and differentiated into a complicated color-pattern. This consists in a light-colored median dorsal broad stripe, strongly constricted between each body segment, and a narrow very dark beaded or interrupted median line, the interruptions of which coincide with the constrictions of the light stripe. Examined under a microscope it is seen that the enlargements of the dorsal light stripe are rhomboidal in form, but coalescent for about half their greatest width along the intersegmental lines, so that their margins form a continuous longitudinal serrate line. The dark color is confined to the space between the body folds and does not include the apices of the papillae, even in the darkest portions of the stripe. The median blackened line is discontinuous, passing over only five to seven folds on each segment and is much more strongly pigmented on the three or four alternate folds of each segmental group. The dorsal color-pattern fades out on the head and next segment, and continues to the posterior extremity of the body, although paler on the last two or three segments. The antennae are pale.

Integument. The integumentary folds are very narrow on the ridges with the transverse grooves between them deep. At the level of each leg two of the folds are incomplete, extending only about half-

way from the median line to the legs when seen in dorsal view. Examined in surface view the papillae appear to be practically all of the same type, large and rather transverse in outline. Seen by transmitted light, accessory papillae are few in number and always appear on the extreme edges of the folds singly or in pairs between two primary papillae, which are farther apart at the points where accessory ones are interpolated. The primary papillae are short-conical in form, with the terminal cylinder poorly developed, short, nipple-shaped; their bases are usually separated by nearly transverse grooves which give the papillae a somewhat rectangular appearance when viewed from above. The accessory ones tend to project over the groove between the body folds and are thus seen more or less in profile when the integument is viewed from above. In one specimen (Plate 1, fig. 1–2) where the skin is stretched from side to side the primary papillae are more widely separated and the accessory ones appear to be drawn up farther toward the ridges of the body folds.

Mandibles. The mandibles bear one large accessory tooth and nine denticles.

Legs. As stated above there are 33–34 pairs of legs in the females and 30 pairs in the single male examined. The legs are provided with three pedal papillae, two on the anterior face and one on the posterior face as in the Caribbean members of the genus. The creeping pads of each leg are composed of four bands. The nephridial tubercles on the fourth and fifth pairs of legs lie between the third and fourth bands of the creeping pad. They are free from the third band although lying partly in an emargination of its proximal margin, and do not disturb the continuity of the fourth band.

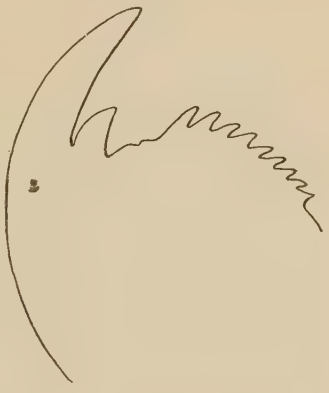


Fig. 1.— *Peripatus* (*Epiperipatus*) *vespuccii.* Outer blade of mandible.

Type:— M. C. Z., No. 239, Cincinnati Coffee Plantation, near Santa Marta, Colombia, 2,300 feet. (Field No. 92).

Paratypes: — M. C. Z., No. 240; Univ. Mich. Same locality, 2,200 feet.

Named in honor of Amerigo Vespucci whose explorations led him along the coast which has yielded so many species of Peripatus.

In Bouvier's key this species will run down to *edwardsii*, but it is quite different from that species in the form and arrangement of the tegumentary papillae, and also possesses a larger number of legs in the female (33–34 pairs), *edwardsii* having only 30–32, rarely 33 in this sex. Were it not for the presence of incomplete body folds the structure of the integument would place it close to *brasiliensis*, although the specimens of *brasiliensis* figured by Bouvier have the primary papillae placed farther apart and the accessory ones ascend to the ridges of the folds. The structure of the fourth and fifth legs is as in *brasiliensis* also, with the nephridial tubercle entirely free from the third band of the creeping pad. It appears impossible, therefore, to associate the present form closely with any described species, although it undoubtedly falls near *edwardsii* while showing a striking similarity to *brasiliensis*. *Peripatus brasiliensis* was described from Santarem, but according to Bouvier probably extends to Panama; *P. edwardsii* occurs from French Guiana to Colombia. The present species is not closely related to any of the forms recently described by Fuhrmann (Zool. anz., 1913, **42**, p. 241–248) from Colombia.

PERIPATUS (EPIPERIPATUS) EDWARDSII Blanchard.

Ann. sci. nat. Zool., 1847, sér. 3, **8**, p. 140.

Of this widely distributed species there are nine specimens (Coll. Univ. Mich. and M. C. Z. No. 241–244), from the Cincinnati Coffee Plantation, near Santa Marta, Colombia.

As can be seen from the accompanying illustrations, there is considerable variation in the distribution of the integumentary papillae, particularly in the accessory ones. These latter vary much both in numbers and in distribution on the body folds, but the variation does not exceed that already observed by Bouvier in this species. All have the nephridial tubercles of the fourth and fifth legs free from the third creeping pad and the fourth pad is continuous. The number of legs is indicated in Table 2.

In the smaller specimens there is a marked difference in the size of the primary papillae which are alternately large with well-developed terminal cylinder and small with reduced cylinder. In these specimens the accessory papillae are sparse and restricted almost exclusively to the edges of the folds (Plate **2**, fig. 7–8). The larger examples (Plate **2**, fig. 6, 9) have the primary papillae of more nearly equal size and similar form and the accessory ones ascend more commonly on the sides of the folds although always remaining away from the ridges.

One unusually large specimen (Plate **2**, fig. 5–6) has the periphery of the papillae unusually well defined by a series of irregular non-pigmented lines which form a noticeable network along the folds. It is possible that there may be one or more varietal or subspecific forms of *edwardsii* that might be distinguished. However, a close study of the material on hand, supplemented by other specimens in the M. C. Z. and in the American Museum of Natural History does not seem to offer any characters of sufficient constancy to warrant any such division.

TABLE 2.

Field number	Length of body		Greatest breadth	Number of legs
	Alive	Preserved	Preserved	
50 (large)	72 mm.	50 mm.	5.7 mm.	30 pairs
50 (small)	42 mm.	31 mm.	3.1 mm.	29 pairs
58	76 mm.	48 mm.	6 mm.	30 pairs
171–172	———	53 mm.	4.5 mm.	32 pairs
171–172	———	43 mm.	3.7 mm.	32 pairs
171–172	———	29 mm.	2.9 mm.	30 pairs
171–172	———	30 mm.	2.8 mm.	29 pairs
171–172	———	24 mm.	2. mm.	31 pairs
179	———	74 mm.	3.7 mm.	32 pairs

PERIPATUS (EPIPERIPATUS) IMTHURMI Sclater.

Quart. journ. micros. sci., 1888, **28**, p. 474.

One specimen, No. 49 of the present collection (M. C. Z. No. 245), seems undoubtedly to belong to this species which has hitherto been reported only from Guiana. It is not very typical but agrees well

in the form and disposition of the papillae as well as in the character of the nephridial tubercle on the fourth and fifth legs. There are 30 pairs of legs, a common number for this species. In color, however, the specimen before me seems to differ somewhat from the normal color of *imthurmi* for according to Professor Pearse's field notes, it evidently showed in life lozenge-shaped markings. Bouvier has found in certain individuals indications of lozenges in addition to the median dark line, however, so that this variation is perhaps of not very great importance. The specimen was fixed in Gilson's fluid and it is impossible at present to see any indications of the original color-pattern.

The present record greatly extends the range of *imthurmi*, but after a long series of comparisons I am convinced that it is either a non-typical or varietal form of *imthurmi*. The single female is from the Cincinnati Coffee Plantation, altitude about 3,000 ft., 18 miles south of Santa Marta, Colombia.

Field Notes and Observations. By A. S. Pearse. All specimens are from the Cincinnati Coffee plantation, 18 miles south of Santa Marta, Colombia. The field numbers are those referred to in the preceding taxonomic account.

49. One Peripatus, in a log 30 × 1½ ft. on a hillside southeast of the Plantation. Altitude about 3,000 feet. July 7, 1913.
50. Two Peripatus, same as 49 per locality and date, in a small stump 1½ ft. high and 5 inches in diameter, with borers (Passalus, etc.) imagoes, larvae, and pupae.
58. Peripatus in a rotten log with one beetle, isopods, ants, etc. Altitude about 5,300 feet. July 8, 1913.

    This log, like the others I had examined up to this time which contained Peripatus, was on an open hillside exposed to the sun, with Pteris growing all around. I found a cricket in this log which was fastened by its dorsal surface by a sticky secretion.
92. Peripatus on the trail toward Minca below the Plantation. Under bark on a live tree about 3½ feet above the ground in a rather dry, dense forest. Altitude about 2,300 feet. July 15, 1913.
151. Small Peripatus in the forest southwest of the Plantation, under leaves. Altitude about 2,200 feet. Died before being preserved. July 21, 1913.
152. Peripatus in the centre of a very soft log which could be torn apart with the hands. Same locality and date as 151.
171. Two small Peripatus beside the trail under the bark of a rather firm log which had been bored by beetles. The bodies of these

two animals were in contact when taken. On the trail toward Minca below the Plantation in forest. Log exposed to full rays of sun. Altitude about 2,100 feet. July 24, 1913.

172. Three Peripatus, same locality as last, one under the bark of a log, two in cavities made by beetles in log.

179. Peripatus under log in forest southwest of the Plantation. Altitude about 2,200 feet. July 25, 1913.

Locomotion. They crawl backward as well as forward, and may use one, two, three, four, five, or six pairs of legs at the anterior end alternately, but may use all pairs of legs together. I placed several in a big white developing tray. They often crawled away from the light, though they frequently went toward it, or without reference to it. Often when they came to the edge of the dish, or sometimes when a card was held between them and the light, they raised the anterior end and waved it about. The last or last two pairs of legs are usually not used in walking but are held quiet above the substratum upon which the animal moves. Often the first three pairs of legs are thus held immobile.

I put Nos. 58 and 50 (large) in a vial with a beetle larva, a silver fish, and a milliped. Although these crawled over the Peripatus it did not shoot out any white threads. I pinched No. 50 (small); it turned its anterior end and shot out a colorless secretion which stuck to the forceps and fastened the myriopod to the tray so that it could not escape. I pinched No. 50 (large), and it gave out a colorless, rather viscid secretion from two ventral lateral papillae on the under side of the head. This secretion fastened the beetle larva to the bottom of the tray, but it soon hardened so that it was not sticky. I pinched it again. The head was turned back and the secretion shot out for a distance of about 2 cm. It formed a reticulate network on the back of the Peripatus and stuck it to my forceps. The Peripatus was unable to free itself from the forceps for an hour, when I released it.

On a later day I squeezed a Peripatus and induced it to throw threads from the bases of several of the legs behind the head.

Note on a Collection of Peripatus from Trinidad and Grenada. During a visit to Grenada and Trinidad during the winter of 1912-13, Prof. Roland Thaxter secured a very extensive collection of Peripatus from these islands, which he has given to the Museum of Comparative Zoölogy. Though unsuccessful in collecting further specimens of *Peripatus barbouri* Brues, a species peculiar to the high portion of Grenada, he obtained a single small specimen, (M. C. Z. No. 199), of

Peripatus collected by Mr. G. Whitfield Smith on the Island of Carriacou. This is quite different from the Grenada species, but it is impossible to identify it with certainty from the unique, evidently immature specimen. Although Carriacou is within sight of the northern coast of Grenada, it lies rather low and its comparatively dry climate is in great contrast to the very moist region in the higher mountains of Grenada where *P. barbouri* occurs.

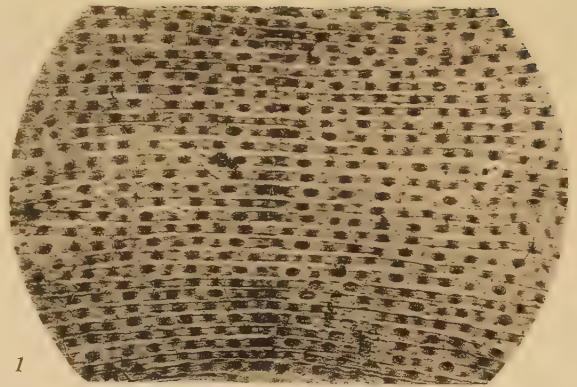
In Trinidad Professor Thaxter obtained fine series of both species hitherto known from that island; six males and seven females (M. C. Z. No. 201–208, 211–214, 217), of *P.* (*Epiperipatus*) *trinidadensis* Sedgwick, and two males and four females (M. C. Z. No. 209–210, 215–216, 218–219), of *P.* (*Macroperipatus*) *torquatus* von Kennel. In addition there is a single female (M. C. Z. No. 200), measuring 88 mm. in length with 31 pairs of legs belonging to *P.* (*Epiperipatus*) *imthurmi*, a species hitherto known only from the mainland of South America.

EXPLANATION OF PLATES.

PLATE 1.

Peripatus (*Epiperipatus*) *vespuccii* Brues.

Fig. 1. Portion of dorsal integument of paratype. (No. 150).
Fig. 2. Same, more highly magnified.
Fig. 3. Portion of dorsal integument of type. (No. 92).
Fig. 4. Same, more highly magnified.



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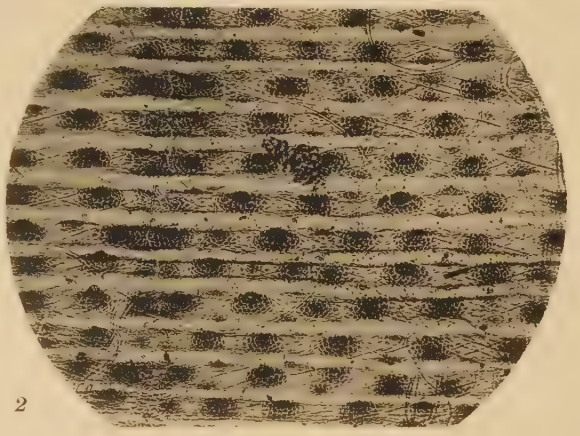

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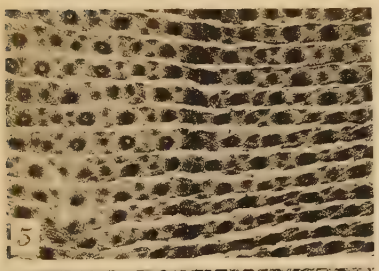
PLATE 2.

Peripatus (*Epiperipatus*) *edwardsii* Blanchard.

Fig. 5. Portion of dorsal integument. (No. 58).
Fig. 6. Same, more highly magnified.
Fig. 7. Portion of dorsal integument. (No. 50 small).
Fig. 8. Same, more highly magnified.
Fig. 9. Portion of dorsal integument. (No. 50 large).
Fig. 10. Lateral view. (Specimen from No. 171–172).

Peripatus (*Epiperipatus*) *vespuccii* Brues.

Fig. 11. Dorsal view of type. (No. 92).
Fig. 12. Portion of dorsal integument of paratype. (No. 151).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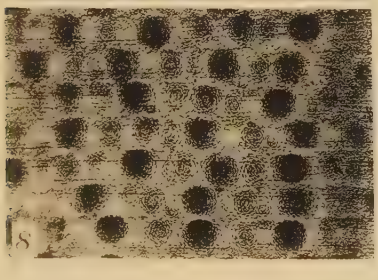
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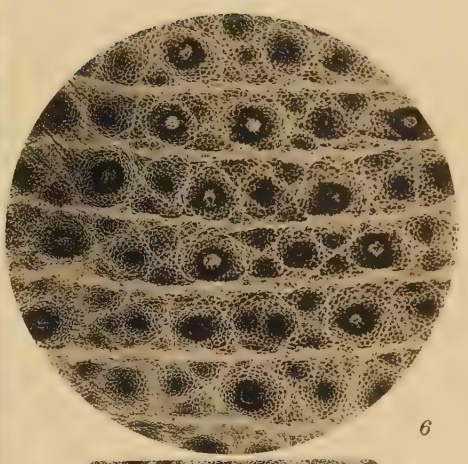
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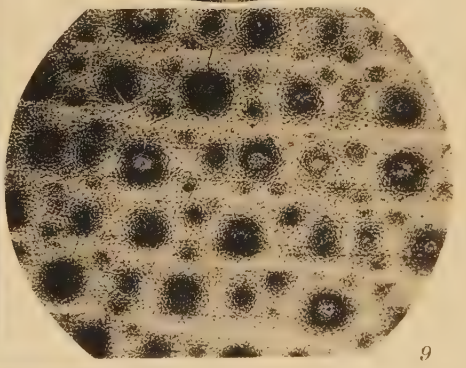
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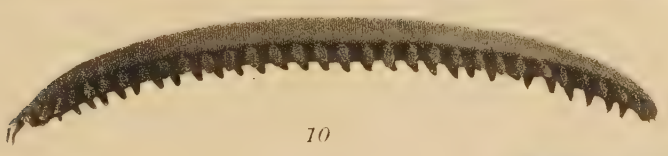
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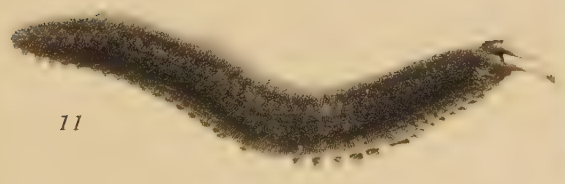
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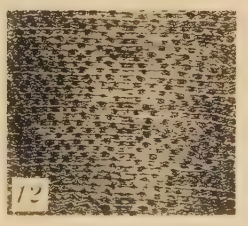
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" The Thalassicolae.
O. CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
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R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
R. VON LENDENFELD. The Siliceous Sponges.
—— The Ophiurans.
G. W. MÜLLER. The Ostracods.
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G. O. SARS. The Copepods.
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Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

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STANFORD EXPEDITION TO BRAZIL, 1911.

J. C. BRANNER, *Director.*

SOME NEW PARASITIC HYMENOPTERA FROM BRAZIL.

CHARLES T. BRUES.

[Reprinted from PSYCHE, Vol. XXII, No. 1]

STANFORD EXPEDITION TO BRAZIL, 1911.

J. C. BRANNER, *Director.*

SOME NEW PARASITIC HYMENOPTERA FROM BRAZIL.[1]

By Charles T. Brues.

In a previous publication,[2] I have dealt with part of a very interesting collection of Parasitic Hymenoptera obtained by the Stanford Expedition to Brazil. Only the Ichneumonidæ and Braconidæ were included in the first paper, and the present one contains descriptions of a number of new species belonging to other families. There are many other species, especially in the superfamily Chalcidoidea which it has seemed inadvisable to consider at the present time, mainly on account of the great difficulty experienced in recognizing with certainty many of the species described by early writers. Descriptions of eleven new species and one new genus are given below while thirty-one new species and three new genera were included in the previous report.

FAMILY STEPHANIDÆ.

Fœnatopus aurantiiceps sp. nov.

♀. Length 14 mm.; ovipositor 16 mm.; wing 8.5 mm. Black; head and base of antennæ bright ferruginous; four anterior legs more or less fuscous; tip of hind tibiæ and hind metatarsus fulvous; ovipositor with a subapical white annulus. Head above transversely aciculate, the aciculations between the ocelli curving forward and forming a series of bowed lines enclosed in a shield-shaped margined area that has its anterior angles tuberculate; on each side of the median ocellus is another tubercle which form an equilateral triangle with a third median one below the ocellus. Face with somewhat irregular transverse aciculations below; above, the aciculations curve upwards laterally passing from the median to the lateral

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 82.

[2] *Ann. Entom. Soc. Amer.*, vol. 5, pp. 193–228.

tubercles. Mandibles obtusely pointed, with an obsolete tooth on each side before tip: paler than the head at base and black at tips, with many stiff yellow hairs near the middle; malar space very short, with furrow. Maxillary palpi 5-jointed, first joint very short, fourth and fifth longest. Antennæ 34 or 35-jointed, reaching to the tip of the first abdominal segment; first two joints ferruginous, remainder piceous; scape twice as long as thick, pedicel obovate somewhat over one-half as long as the scape; first flagellar joint equalling the scape, but one-fourth as thick as long; following 4 or 5 joints nearly equal, each about one-half longer than the first; remaining ones gradually shortening and becoming more slender. Cheeks and temples smooth and polished, sparsely clothed with yellowish hairs near the base of the mandibles. Prothorax transversely striate; as long as the head above and evenly widened behind when seen from above. Mesonotum very short, irregularly areolate, but with a pair of contiguous well-defined squarish areolæ medially behind. Axillæ large, faintly striate, each with two foveæ toward the median line behind; separated from the scutellum and from one another by crenate impressed grooves; scutellum smooth centrally, but with a few foveæ or large scattered punctures on the sides. Metanotum with large, rather closely placed circular foveæ, the spaces between them showing fine transverse aciculations. Petiole of abdomen straight, of equal thickness throughout, twice as long as the thorax, exclusive of the pronotum, its entire surface somewhat irregularly transverse-striate, on each side with a lateral carina that is much more distinct near its origin at the anterior angles; second segment scarcely over one-third as long as the first, at the extreme base above with transverse striæ; toward the middle microscopically shagreened, and apically microscopically transversely aciculate. Following segments showing very faint traces of aciculation except the last which is faintly shagreened. Mesopleura smooth above, obliquely raised along an oblique line from the base of the middle coxa to below the tegula; on the pleura below and on the pectus transversely aciculate, with some large confluent punctures intermixed anteriorly and just below the lateral ridge. Metapleura sculptured like the metanotum, with a lateral carina which becomes obsolete anteriorly. Fore and middle legs piceous, with the base of the femora, knees and base of metatarsus brownish. Hind coxæ half as long as the petiole of the abdomen and resembling it in size and sculpture except that they are thickened beyond the middle. Hind femora with three teeth below, the largest one at the middle, the next halfway toward the apex and the smallest one-third way to the base; nearer the base is a still smaller, obsolete tooth; in addition with three very small denticles between the middle and subapical tooth. Posterior tibia inwardly at apex with a small pad of yellowish white hairs. Wings hyaline, with fuscous veins; radial cell open on its apical fifth; median and submedian cells closed, of equal length; discoidal cell with only its basal and upper sides indicated by veins. Tegulæ at tip, and root of wing, fulvous.

One female from Manaos, Brazil (Mann & Baker).

This is the second species of Fœnatopus to be described from Brazil, all the others being of African provenience. It differs from *F. annulipes* Kieffer from Pará, Brazil, by its orange-colored head, absence of transverse striæ on the mesonotum and lack of

punctures on the sides of the prothorax, as well by its shorter ovipositor. It is also much smaller, 14 mm., instead of 30 mm.

FAMILY EVANIIDÆ.

Hyptia libertatis sp. nov.

♂. Length 4.5 mm. Head, prothorax, scape of antennæ, fore legs, spot on base of their coxæ, and middle legs ferruginous or fulvous; otherwise black. Entire head deeply pitted with thimble-shaped punctures, those on the front quite plainly arranged in arcs with the base of the antennæ as center; between the punctures with faint aciculations running with the lines of punctures on the front and vertically on the cheeks. Inner orbits narrowly impunctate below and continued across the malar space as a raised smooth strip. Punctures of posterior part of head arranged in vertical lines. Below the antennæ the color of the head becomes much lighter, pale yellowish brown; mandibles of same color, with black tips; palpi fuscous, paler at the articulations. Antennæ 13-jointed; scape ferruginous, flagellum piceous; scape four times as long as thick at apex, as long as the first and second joints of the flagellum taken together; pedicel as long as thick, half as long as the first flaggellar joint; flagellar joints increasing very slightly in length from the first to third and subequal from thence onward; those at the middle distinctly thicker than at base and apex; joints 1 to 6 twice as long as thick. Thorax above punctured like the head, with distinct transverse aciculations between the punctures on the mesonotum. Metathorax just above the insertion of the abdomen with a small smooth, polished space. Propleura smooth, with an oblique femoral impression; at root of wing and below with several foveæ. Mesopleura with a smooth femoral impression above which are several irregular foveæ, and below finely punctate with some large punctures intermixed. Metapleura reticulate, with the femoral furrow smooth on its lower half; posterior declivity of metathorax similarly reticulated, but so densely clothed with silvery pubescence that the sculpture is nearly obscured. Abdominal petiole longitudinally aciculate above, with sparse, medium-sized punctures, and sparsely clothed with appressed glistening white hairs; body of abdomen obovate, highly polished. Four anterior legs, except middle coxæ, fusco-ferruginous; hind legs entirely black, their tibiæ and tarsi without spinules; longer spur of tibia half the length of the metatarsus. Wings hyaline, venation piceous; costal cell complete; submedian vein as long as the costal cell, with a swelling just beyond its middle.

One specimen, Independencia, Parahyba, Brazil, Mann and Heath.

This pretty little species resembles *H. spinulosa* Kieff., but has the hind legs black and lacks the spinules on the hind tibia.

FAMILY CHALCIDIDÆ.

Eniaca neotropica sp. nov.

♀. Length 3.8 mm. Head and thorax æneous; abdomen black; antennæ, four anterior legs and hind tarsi ferruginous; fore wings strongly tinged with brown,

hind ones hyaline. Head above very coarsely and closely punctate so as to appear reticulate, each depression with a stiff glistening hair at its center. Anterior median emargination as deep as the length of the eye when seen from above, just reaching the median ocellus. Each side of the frontal horns margined above and below on its carinate lower edge. Antennæ 13-jointed, the scape slender, obclavate; flagellum considerably thickened toward the apex; one ring-joint, the first flagellar joint slightly longer than the pedicel, one-third longer than the second which is quadrate; following joints to the club of about equal length, but becoming thicker. Length of head below twice its height. Thorax sculptured like the head, the scutellum weakly carinate medially on its anterior half, the carina extending over the mesonotum where it is, however, less distinct. Metanotum with its lateral angles strongly produced into large, blunt teeth, posterior angles more acutely produced into small teeth; lateral margins carinate and the pleural surface separated from the dorsal one by a carina which curves inward medially; metanotum coarsely, obliquely reticulate on its anterior half, which bears a large shield-shaped areola; behind with a Y-shaped carina that defines a pair of areolæ at the apex of the metanotum. Pleuræ sculptured like the notum, except the large mesosternal furrow which is closely, transversely striated; metapleuræ below on each side with two tooth-like projections along the posterior margin. Petiole of the abdomen with four longitudinal carinæ above in addition to another somewhat oblique carina on each side; between the carinæ minutely roguse; seen from above, the petiole is as long as broad at base and distinctly widened apically. Second segment covering two-thirds of the abdomen, its posterior margin strongly curved forward medially; basal two-fifths longitudinally striate except on the sides remainder highly polished, except for a faint shagreen on the sides; following segments smooth anteriorly, shagreened posteriorly and clothed with sparse glistening hairs laterally. Hind femora below (on the outer side) with a series of closely placed minute, pectinate teeth; above with a fine carinate line, but no teeth. Wings with the marginal vein one-fourth longer than the submarginal; stigmal and postmarginal not developed. Ovipositor not extruded.

One specimen form Ceará–Mirim, Rio Grande do Norte, Brazil. Wm. M. Mann.

This species may be distinguished as follows:

1. Antennæ, or at least the entire flagellum, black..... 2
   Antennæ entirely ferruginous (Brazil) *neotropica* sp. nov.
2. Scape of antennæ rufous, flagellum black; hind tarsi red. (Texas, (U. S. A.).....*texana* Ashm.
   Antennæ entirely black; hind legs entirely black.....*hesperidum* Rossi.

Family PERILAMPIDÆ.

Perilampus injactans sp. nov.

♀. Length 2.5 mm. Head and thorax black, pleuræ and abdomen with a purplish blue reflection; antennæ reddish brown near tips, especially below; femora black, with strong blue reflection, tibiæ fuscous, pale yellow at base and apex, tarsi

yellowish white, with the extreme tip dark. Wings hyaline. Occiput behind the ocelli finely, irregularly transversely striate and finely shagreened forward to the level of the anterior ocellus. Facial basin smooth and polished, margined laterally by a raised line that separates it from the narrow orbits and curves inward above to include the anterior ocellus. Lower corners of facial basin striated, their striæ extending upwards for a short distance along the orbits. Clypeus with a few large shallow punctures; face at sides of clypeus minutely rugulose; genæ vertically striated, these striæ extending upwards to meet those on the occiput. Thorax and scutellum umbilicately punctate except for the axillæ and a space external to each parapsidal furrow. Scutellum with a carinate margin that is emarginate at tip to form two blunt teeth. Tegulæ rufo-fuscous. Metathorax with a strong median carina. Mesopleura with a large, irregular depression above and a number of smaller, circular foveæ below. Wings with the marginal vein distinctly longer than the post marginal and twice as long as the stigmal.

One specimen, Ceará-Mirim, Rio Grande do Norte, Brazil, Wm. M. Mann.

This species has the orbital space on the sides of the front usually narrow, and only slightly widened above; the eyes are large, separated by only the width of the antenna from the base of the mandibles, and the malar furrow is distinct. There is no ridge or carina on the face near the side of the clypeus. It is most closely related to *P. bakeri* Crawford recently described from North America, but the facial carinæ extend below the insertion of the antennæ, and the scutellum is deeply emarginate at apex.

Family CLEONYMIDÆ.

Pelecinella Westwood.

There is a specimen of this remarkable genus which represents an undescribed species. Three species have previously been described, all from Brazil, which may be distinguished from the present one as follows:

Key to the Species of Pelecinella.

1. Body and legs mainly black, with more or less bluish, greenish or purplish reflections 2
   At least the abdomen in great part rufous; legs rufous or brown 3
2. Prothorax rufous on the sides; joints 2–4 of hind tarsi white, hind metatarsus black ..... *phantasma* Westw.
   Prothorax entirely black; hind metatarsus white, following joints dark brown or piceous ..... *ashmeadi* sp. nov.
3. Head above, and thorax above (rarely entirely), abdomen, except segments 2 and 3, black; ovipositor half as long as the body ..... *howardi* Ashm.
   Head, thorax, except above, and abdomen, rufous ..... *westwoodi* Ashm.

Pelecinella ashmeadi sp. nov.

Female: Length 22 mm.; ovipositor 14 mm. Black, slightly æneous on the head, thorax, petiole of abdomen and legs; abdomen greenish on the second segment and with a purplish-blue cast on the third and following segments. Hind tarsi with the first joint entirely yellowish white, the succeeding joints fuscous; second trochanter on front legs and extreme base of four anterior metatarsi rufous or yellowish brown. Body slightly white-pubescent on the thorax and legs, densely so on the face, the hairs on the hind tibiæ stiff and erect though short, black on the apical third of the tibia. Head deeply furrowed medially above the antennæ; on the sides striate above the middle, vertically rugoso-striate below. Antennæ as in *P. phantasma*. Face shagreened, with a shield-shaped bare area medially just above the lower margin; cheeks with a few large punctures; malar line distinct. Prothorax finely transversely aciculate above, smooth laterally; mesonotum more coarsely aciculate, smooth and sparsely punctate on the posterior part of the lateral lobes exteriorly; axillæ and scutellum sparsely punctate, not separated anteriorly. Metanotum transversely aciculate on its posterior half as well as near the median line anteriorly, towards the anterior angles sparsely punctate and on the pleuræ behind densely punctate. Pro- and mesopleuræ closely punctate, the latter with a long, deep, smooth femoral furrow. Petiole of abdomen very finely transversely aciculate above, cylindrical in form, as long as the hind coxæ; remainder of abdomen smooth, as usual in the genus. Anterior tibiæ each with nine or ten fine teeth or denticles along the inner margin, those toward the apex smaller and more approximate. Hind coxæ with a few transverse striæ above toward the apex. Wings hyaline; marginal vein four-fifths as long as the submarginal; stigmal punctiform; postmarginal attaining the wing-tip.

One specimen, Abuná, Rio Madeira, Brazil. Mann and Baker.

It gives me great pleasure to be able to dedicate the present species of this most remarkable genus to my friend, the late William H. Ashmead, who showed me years ago the two Brazilian species which he himself described.

FAMILY SCELIONIDÆ.

Hoplogryon fortis sp. nov.

♂. Length 2 mm. Black; legs fuscous; basal half of antennal scape brownish; wings hyaline, with fuscous veins. Head, seen from above, fully twice as broad as thick anteroposteriorly; occiput and temples weakly striate, the striæ extending parallel to the raised posterior margin of the head; ocelli large, in a small triangle, the posterior ones one-half farther from the eye-margin than from one another; front above polished, on its lower half coarsely vertically striated, the striæ extending higher on the sides than at the middle and converging below so as to pass between the base of the antennæ and the eyes, leaving a smooth stripe extending upwards from between the antennæ; cheeks striate, their striæ converging with those of the front toward the anterior edge of the insertion of each mandible; clypeus

transversely striate. Antennæ 12-jointed, scape reaching to the anterior ocellus; pedicel globular, one-third as long and nearly as thick as the first flagellar joint; second and third each somewhat shorter than the preceding; following subequal, the apical ones somewhat longer and considerably more slender; third flagellar joint scarcely over twice as long as thick and only feebly toothed beneath. Mesonotum shining, with sparse, rather weak punctures, longitudinally striate medially on its posterior half, the striated area not extending more than halfway from the median line to the tegulæ. Scutellum finely, irregularly rugose, a small space on the middle of its disc more finely sculptured; with a punctate line just inside of the posterior edge which is raised; postscutellum with a stout thorn which appears triangular in dorsal view. Metathorax closely rugose, its posterior angles produced as prominent thorns of about the same size as the postscutellar one. Pronotum not visible from above, finely sculptured, but shining; propleuræ rugoso-punctate, more finely so below; mesopleura with an oblique femoral impression which is transversely marked with coarse grooves; metapleura shining, with a small impression near the middle and a few oblique striæ at the base of the coxa. Abdomen obovate; petiole a trifle longer than wide at base, twice as wide at apex as at base, with parallel longitudinal striæ; second segment one-third longer than the first, nearly twice as broad at apex as at base, with a depression across the base, striated, the striæ spreading out fan-shaped behind and becoming much finer laterally where they are parallel with the lateral margin of the segment; third segment no wider at apex than at base, as long as wide and as long as the first and second together; finely longitudinally striated except at extreme apex, its striæ parallel; following segments smooth, rapidly growing shorter. Marginal vein long, a little more than half the length of the submarginal; stigmal vein one-fourth as long as the marginal and scarcely knobbed at tip; postmarginal wanting.

One specimen from Independencia, Parahyba, Brazil, Mann and Heath.

The very large and stout metathoracic spines, short antennal joints and abdominal sculpture will serve to distinguish this species from its congeners.

Macroteleia herbigrada sp. nov.

♂. Length 4.5 mm. Black, legs; except coxæ brownish yellow; antennæ brownish yellow below, piceous above; wings subhyaline, with fuscous venation. Head about half wider than thick antero-posteriorly, above with coarse separated punctures which have a tendency to assume longitudinal series behind the ocelli; in front of the ocelli they are irregular and farther apart, except for a dense row of smaller ones along the inner eye-margin; front medially with a shallow, smooth depression to receive the antennal scapes; malar line deep, over half as long as the scape, the front above it closely punctate; cheeks and temples coarsely and more sparsely so. Eyes bare; ocelli large, especially the posterior ones which almost touch the eye-margin. Antennæ 12-jointed; scape as long as the narrowest width of the front; pedicel slightly shorter than the first flagellar joint, which is twice as

long as thick, these together as long as the scape; second flagellar joint rounded, but little longer than thick; third one-half longer than thick, larger than the second and excised beneath; fourth to ninth passing from submoniliform to subquadrate each somewhat longer than thick. Pro- and mesonotum coarsely and sparsely punctate, shining; the punctures larger on the pronotum behind; parapsidal furrows complete, straight; almost twice as far apart in front as behind; lateral margin of mesonotum with a deep groove next to the tegula which extends forward along the lateral margin as a crenate line to meet the parapsidal furrow. Scutellum with a curved row of very large, closely placed punctures anteriorly and a similar straight row posteriorly; its disc finely and sparsely punctate; postscutellum very short, of even width, coarsely longitudinally grooved. Metathorax with two blunt teeth behind toward the sides. Propleuræ irregularly sculptured, smooth on the upper anterior portion; vertical strip between pro- and mesopleuræ longitudinally grooved; mesopleuræ with an oblique depression to receive the femora, this depression smooth except for an oblique line of punctate grooves behind the middle; metapleuræ irregularly rugose; mesosternum coarsely punctate. Abdomen twice as long as the head and thorax together; first segment scarcely longer than broad, toward each side with a longitudinal carina that extends backwards as far as the apex of the third segment; between these with three carinæ that converge and become weaker behind, only the middle one extending on to the base of the second segment; between the carinæ the first segment is more or less distinctly irregularly longitudinally striate. Second segment twice as long as broad, punctate-reticulate; third segment a little longer, similarly sculptured; fourth as long as the second, fifth and sixth growing shorter, narrower, and more finely sculptured. Venter punctate, sparsely pale pubescent and with a stout median carina. Legs obscure brownish yellow the clavate portion of the hind femora infuscated. Marginal vein one-half longer than the stigmal; postmarginal nearly twice as long as the marginal.

One specimen from Independencia, Parahyba, Brazil, Mann and Heath. This was taken in sweepings.

Hoploteleia pallipes sp. nov.

♂. Length 4.8 mm. Head, including flagellum of antennæ, postscutellum, metathorax and abdomen, black; lower part of mesopleuræ piceous; mesonotum and propleuræ ferruginous; legs light brownish-yellow, coxæ fuscous; wings subhyaline. Head twice as broad as thick; ocelli large, in a triangle, with the lateral ones removed by less than their diameter from the eye-margin; surface of head with large, separated thimble-shaped punctures above, on the front, and cheeks, the ones on the cheeks more irregularly placed; mandibles ferruginous. Antennæ 12-jointed; scape brownish-yellow below, almost as long as the three following joints; pedicel much constricted at base, pale below; two-thirds as long as the first flagellar joint; first flagellar joint twice as long as thick; following becoming almost imperceptibly shorter to the longer, pointed apical joint; flagellum scarcely thickened apically. Eyes large, broadly oval, bare. Mesonotum with a few, irregularly placed, large punctures; parapsidal furrows deep, straight, converging behind; median furrow complete, but not so deeply impressed. Scutellum large,

with straight base and sides, narrowed behind; its base with a series of three impressions on each side, the lateral one largest and the median one smallest; disk with very large, close-set punctures; apical margin with a series of small foveæ; lateral margins carinate. Postscutellum, or base of metanotum produced into a bidentate median process; margin separated at the base from the scutellum by a curved, coarsely crenate line; its anterior margin carinate on each side, the carinæ extending to the bidentate process; on each side of the process with a triangular areola, below which the metathorax is densely white-hairy. Propleuræ coarsely punctate above, smooth below; mesopleuræ obliquely impressed medially with a series of horizontal grooves, distinct around the edges, but obsolete near the middle of the impression; mesosternum rather coarsely punctate; metapleuræ irregularly rugose. Abdomen one and one-half times as long as the head and thorax together; of six visible segments, gradually widening to the apex of the third, then gradually narrowed to the truncate, bispinose apex; first segment one-third longer than wide at the tip, which is one-third broader than the base; with two approximate longitudinal carinæ medially, which enclose a deep, smooth furrow; laterally with a carina which extends backwards to the tip of the fourth segment; its surface like that of the succeeding segments, pitted with coarse punctures which assume a very decided longitudinal linear arrangement on the first to fourth segments; second segment as long as broad at apex, narrower basally; third and fourth segments quadrate; fifth smaller and narrowed at apex; sixth half as long, rounded at tip except for the two spines. Legs slender. Anterior wings with the submarginal vein extending nearly half the wing-length; marginal vein about five times as long as thick, almost as long as the straight, oblique, knobbed stigmal vein; postmarginal vein twice as long as the marginal; several other veins faintly indicated by thickenings; hair fringe very short; tip of wing attaining the tip of the fifth segment of the abdomen.

One specimen, Pará, Brazil, Wm. M. Mann. This species is very different in the sculpture of the head and abdomen and in wing venation from the Brazilian *H. rufidorsum* described from Rio de Janeiro by Kieffer.[1]

Family DIAPRIIDÆ.

Xanthopria gen. nov.

Head rounded, produced at the insertion of the antennæ. Eyes bare; ocelli in a triangle, far from the eye-margin. Antennæ 11-jointed, gradually swollen toward the tip, the club, although not distinctly marked off, including five or six joints. Mesonotum without parapsidal furrows, its posterior margin straight or slightly arcuate; axillæ somewhat elongate oval, but with the anterior and posterior margins more or less parallel; scutellum with a large oval or trapezium-shaped depression at the base, convex, with a median carina posteriorly which is sometimes elevated to form a distinct tooth. Metathorax with a median, backwardly-curved tooth or spine at the base; with median, lateral and transverse posterior carinæ; the posterior angles somewhat produced. Abdomen with the petiole about as wide as long; second segment very large, others extremely short; fore wings with-

[1] Ark. f. Zoöl. vol. 1, p. 533. (1904.)

out, or with a very short, hair-fringe; marginal vein attaining the basal-third of the wing, the stigmal vein swollen, oblique, more or less wedge-shaped. Legs rather short; tibial spurs very short.

Type: X ♂. *opaca* sp. nov.

This genus seems to be most closely related to *Acanthopria* Ashmead represented in the West Indian Islands, differing, however, in having only eleven antennal joints. Only three other genera in the family have 11-jointed antennæ, *Notoxopria*, *Solenopsia*, and *Doliopria* and none of these are closely related to the present genus.

Xanthopria opaca sp. nov.

♀. Length 1.6–1.7 mm. Light fuscous, head piceous below the antennæ and about the ocelli; abdomen blackened along the sides and at apex; legs and antennæ considerably lighter than the body. Ocelli close together in a triangle the posterior pair a little farther from the eye-margin than from one another; vertex strongly elevated at the ocelli, the front with a vertical grooved depression between them and the antennæ; eyes ovate, rather small, with large facets, acute below; face slightly convex, the small clypeus protuberant; entire head closely, minutely rugose, opaque, except for a subshining area on the cheeks; antennæ nearly as long as the body, 11-jointed; scape as long as the four following joints together; pedicel cylindrical, as long, but thicker than the second flagellar joint and three-fourths as long as the much more slender first flagellar joint; third and following joints of flagellum about equal, but becoming thicker, the club very gradual, but rather distinctly 6-jointed, its joints except the last nearly quadrate. Mesonotum without parapsidal furrows, its posterior margin straight; scutellum with a large trapezium-shaped depression at the base to each side of which lie the axillæ and behind which lies the convex, rounded-quadrate body of the scutellum; scutellum behind with a short median carina; post-scutellum unarmed; metanotum with a median, blunt spine at the extreme base; the lateral and posterior margins raised and the posterior angles slightly projecting; entire mesonotum, axillæ, scutellum and propleuræ finely rugose, opaque; mesopleura shining except above; metapleuræ finely rugulose, shining, with a deep circular impression above, clothed with sparse wooly hairs above. Abdominal petiole as long as broad, a little narrowed basally, with sparse wooly hairs above; second segment occupying three-fourths of the abdomen, widest at the middle, with arcuate sides, smooth and highly polished; third segment short; others scarcely visible. Legs rather stout, tibial spurs minute. Anterior wings short and broad, distinctly brownish especially on the anterior half, entirely without hair-fringe; submarginal vein one-third of the wing length, gradually thickened before the short, stout, oblique stigmal vein; hind wings with a long fringe on the posterior edge.

Three specimens, Independencia, Parahyba, Brazil, Mann and Heath.

Xanthopria nitida sp. nov.

♀. Length 1.5 mm. Ferruginous, the abdomen beyond the petiole piceous, the head infuscated above and the legs brownish-yellow. Head smooth and shining, with a few conspicuous hairs; ocelli as in the preceding species; front without a median depression; antennæ with the scape as long as the four following joints together; pedicel as long as the second flagellar joint, thicker apically; first flagellar joint slender, one-fourth longer than the pedicel; fourth and following joints, except the last, more or less moniliform, the club very gradual, but rather distinctly 6-jointed; eyes oval, more narrowed below; face convex, slightly sculptured, but shining. Mesonotum polished, smooth, without parapsidal furrows; fovea at base of scutellum rounded, scutellum smooth, with a short, sharp carina which is elevated behind so as to appear as a tooth when seen from the side; metanotum with a sharp median tooth curved backwards; behind this with a median raised line extending to the raised posterior edge; sides also with a broad, carinate margin, the two areas thus formed smooth; posterior angles sharply produced; pleuræ smooth and polished, except the metapleuræ which are rugulose and clothed with short sparse hairs. Abdominal petiole as broad as long, clothed with short, glistening hairs; second segment covering three-fourths of the abdomen; three following segments very short, subequal. Anterior wings subhyaline, yellowish apically; vein one-third the wing length gradually thickened before the short, oblique stigmal vein; margin with a short hair-fringe apically and behind. Legs as in the preceding species.

Two specimens from Independencia, Parahyba, Brazil, Mann and Heath.

This species although similar to the preceding, differs by its shining head and thorax, spined scutellum and distinct median carina on the metathorax.

Hoplopria grandis sp. nov.

♀. Length 7 mm. Black, the legs more or less piceous; wings brown, with three hyaline spots along the anterior border and a hyaline streak on the disc. Head smooth and polished above, the large ocelli on a distinctly raised area; no spine between them; occiput prolonged into a narrow obtuse projection; front smooth and polished, the ledge below the antennæ very prominent, margined; face with a grooved depression on each side which meets the one of the opposite side above to form a large depressed area; below each groove extends laterally around the edge of the clypeus. Eyes large, oval, bare; cheeks as wide as the eyes, smooth and polished. Antennæ 12-jointed; scape distinctly longer than the head-height, arcuate, irregularly striated, bispinose at tip; pedicel half the length of the first flagellar joint; second flagellar joint two-thirds as long as the first and nearly three times as broad as long; third to fifth growing shorter and thicker; the fifth to eleventh quadrate; seventh to ninth widest, but the club is not at all pronounced. Head behind with a dense tuft of woolly hair below the level of the upper eye-margin. Prothorax with a dense collar of wool like that on the head; mesonotum smooth,

without parapsidal grooves, but with a median shallow, broad depression, a similar one on each side and a short narrow deep groove next the lateral margin behind the tegula. Scutellum with a large, oval impression at the base each side of the median line and a second one near the lateral edge; the middle of the disc convex, with an impression on each side and three longitudinal carinæ behind it; postscutellum with three strongly raised longitudinal carinæ. Metathorax at the base with a curved thorn, shaped like a bird's beak; concave on each side behind the thorn. Petiole of abdomen four times as long as broad; above with six longitudinal broad, and very shallow, opaque grooves, separated by shining lines; with a covering of whitish woolly hairs along the sides and below, and with a ring of loose sparse, woolly hairs before the apex; second segment lanceolate, nearly twice as wide at apex, and three times as wide at middle, as at base; smooth and polished; three times as long as the remaining segments together; third and fourth segments short, subequal, each with a minutely punctate band across the middle bearing a series of stiff hairs; fifth segment narrow but about twice as long as the fourth, finely punctulate and sparsely clothed with stiff hairs. Pro- and mesopleuræ smooth, polished; metapleuræ very rough, but clothed with dense white pubescence. Legs piceous, tarsi lighter, especially the front ones; sparsely hairy, the hind coxæ densely so. Wings deep fuscous, lighter apically and behind; costal vein falling distinctly short of the middle of the wing; marginal vein two and one-half times as long as thick; stigmal very short, punctiform; wing membrane with a hyaline streak below the submarginal vein, more distinct basally, a triangular hyaline area just beyond the stigmal vein, a small, oval subapical hyaline area, well separated from the stigmal one, and a hyaline streak on the disc from the basal third to the apical fourth; hind wings subhyaline.

From Porto Velho, Rio Madeira, Brazil, Mann and Baker.

This large species may be recognized by the color pattern of the anterior wings, the form of the abdominal petiole and the contour of the spine at the base of the metathorax. It falls near *H. rufipes* Kieffer, *H. spinosiceps* Kieffer and *H. bicarinata*, but differs from these in the wing-picture, and abdominal petiole and from the second by the unarmed head.

Galesus debilis sp. nov.

♀. Length 2.4 mm. Black; legs, except coxæ, ferruginous; wings subhyaline, folded longitudinally and deeply notched at apex. Head one-half longer than wide; shining; above with an outwardly bowed series of three large punctures on each side of the median line, with two more along the occipital margin each side of the posterior median one, and a smaller one each side of the middle median one; eyes margined above by an impressed line, separated from the front by a carina which is more pronounced anteriorly; head on the sides with a large impression below each eye; eyes round, bare. Antennæ 12-jointed; scape twice as long as thick; longitudinally grooved; pedicel one-half longer than the first flagellar joint which is one-third longer than thick at apex; second to fourth quadrate-monili-

form; following, except last, moniliform, enlarging and becoming quadrate. Posterior ocelli as far from one another as from the eye-margin, each connected to the eye-margin by a raised line. Pronotum with a series of large punctures along its posterior edge. Mesonotum shining, almost impunctate; parapsidal furrows complete, converging behind, of equal width throughout; lateral lobes of mesonotum scarcely depressed; a deep foveate impression in front of the tegula. Scutellum with two large hoof-shaped foveæ at base, at apex with two small circular ones. Metathorax with a carina in the shape of an inverted V. Petiole twice as long as broad, with three strong longitudinal carinæ above, and a weaker lateral one, marking off four shallow grooves; second segment with the base raised and medially notched from behind; its median furrow extending nearly to the middle. Pro- and mesopleuræ smooth and shining, each margined by a raised line; metapleura pubescent, coarsely reticulate. Legs stout. Wings strongly pubescent, except at extreme base.

One female from Independencia, Parahyba, Brazil, Mann and Heath.

This species resembles *G. sulcaticeps* Kieffer, differing by its larger size, longer petiole, shorter first and second flagellar joints and longer scape. In certain lights the front shows a trace of the median lanceolate area present in *sulcaticeps*.

THE BACTERIAL DISEASES OF CATERPILLARS

By R. W. GLASER

[Reprinted from Psyche, Vol. XXI, No. 6]

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THE BACTERIAL DISEASES OF CATERPILLARS.[1]

By R. W. Glaser.

There seems to be a considerable amount of collateral evidence that caterpillars are subject to bacterial diseases, but I am not familiar with a single case where this has been conclusively proved. Such a state of affairs can be explained in part by the fact that much of the work on caterpillar diseases was done before the introduction of Koch's technical methods in 1880 or shortly after, before these methods had been fully perfected. Within compara-

[1] Contribution from the Bureau of Entomology in coöperation with the Bussey Institution of Harvard University. (Bussey Institution, No. 83.)

tively recent times diseases occurring in the same caterpillar, but totally different etiologically were confused with one another. The same name was often given to two distinct diseases and *vice versa*, the same disease was designated differently by different workers. Furthermore, the cultural and biological characters of the bacteria isolated were never thoroughly studied and hence no two investigators knew whether they were dealing with the same or different species. Many people untrained in bacteriology entered this field and helped to swell the enormous literature already accumulated with their inexact observations and careless experiments. Everyone familiar with the subject knows how difficult it is, how careful one has to be in drawing conclusions and how easily serious mistakes are made. From a consideration of some of the more important contributions to our knowledge of the bacterial diseases of caterpillars, the present condition of the subject will become apparent as well as the vast number of problems yet unsolved.

Flacherie and the Clinical Picture of an Infected Silkworm.

The diseases known as "flaccidezza," "lethargia," "negrons," "mortipans," "maladie de tripes," "maladie de morts-blancs," "maladie des morts-flats," "schlaff-sucht," "faulsucht," "flaccidity," "schizomycosis," and "caterpillar cholera" are synonymous with the one known as flacherie.

Flacherie appeared in the silk industry as an epidemic at the end of the sixteenth century. The larvæ usually contract the disease, which is characterized by its acuteness, after the fourth moult or at the time of spinning. Sick caterpillars show very few outer symptoms except loss of appetite and sluggishness. Sometimes their skin becomes black but in other cases they retain a healthy appearance till death. Soon after death the body becomes soft, flabby and dark colored in twenty-four to forty-eight hours and is filled with a brown-black liquid which is said to contain many bacteria.

The Etiological Factor of Flacherie in Silkworms and Other Caterpillars.

In 1870 Pasteur recognized flacherie in silkworms as a distinct disease capable of transmission to healthy larvæ by the infection of their food, either with the excrement of sick individuals or with

the dust of infected silkworm nurseries of the year before. Pasteur believed that a number of organisms, which multiplied in the intestine, were responsible for the disease. In 1873 Bolle found that bacteria were very plentiful in the bodies of silkworms affected with flacherie. In 1886, S. A. Forbes found that the alimentary canal of silkworms during the first stages of the disease was full of micrococci. He also obtained these micrococci from the blood in pure culture and believed them to be identical with *Steptococcus bombycis* described by Cohn. Forbes says that the disease can be transmitted by means of this bacterium and larvæ so infected die after twenty-four to forty-eight hours. He further states that the disease is not transmitted through the egg and that the bacteria retain their vitality for years.

In 1891 Macchiali found two organisms responsible for flacherie, namely, *Streptococcus bombycis* and a *Bacillus bombycis*.

In 1893 Wachtl and Kornauth expressed the belief that the bacteria found by Pasteur in 1870 are identical with *Microzyma bombycis* described by Béchamp in 1867 and identical with *Streptococcus bombycis* Cohn. At about the same time Cramer, Cuboni and Garbarini considered *Streptococcus bombycis* to be the causative agent of flacherie.

In general, *Streptococcus bombycis* seemed to be the form most frequently encountered and the controversy practically subsided with the acceptance of this bacterium as the etiological factor of flacherie in silkworms.

In 1903 Kelly made the remarkable statement that "flacherie is but another name for indigestion." Other theories as far-fetched as the above followed in rapid succession, the most extreme, perhaps, being the one advanced by Sawamura in 1906. He says: "The writer has inferred from his experiments that the flacherie of silkworms can be caused by various bacteria of general occurrence. During that disease no specific bacteria can be found which would be restricted to the occurrence in that epidemic. The following bacteria were found by the writer to produce flacherie by multiplying in the body of the silkworm:

1. *Bacillus coli.*
2. *Bacillus Ellenbachi.*
3. *Bacillus ferrugenus.*
4. *Bacillus fuchsinus.*

5. *Bacillus megaterium.*
6. *Bacillus megaterium bombycis.*
7. *Bacillus mycoides.*
8. *Bacillus pyocyaneus.*
9. *Bacillus rubefaciens.*
10. *Bacillus viridans.*
11. Various species of Proteus.
12. *Micrococcus (Staphylococcus) pyoyenes aureus.*

Our knowledge of the etiology of flacherie in silkworms has not advanced in the least since Pasteur's time and the same thing can be said of other caterpillar diseases of a supposedly bacterial nature.

Forbes in 1886 and 1888 described flacherie-like diseases in the caterpillars of *Pieris (Pontia) rapæ*, *Datana ministra*, *Datana augusi*, *Mamestra picta*, *Pyrameis cardui*, and *Nephelodes violans*. In 1888 he said that "all the bacterial diseases of insects thus far carefully studied, take first and principal effect on the epithelial layer of the alimentary canal, no distinctively blood disease having yet been distinguished if we except a supposed flacherie of *Cleonus* larvæ reported by Metschnikoff in Russia, but not critically investigated."

The flacherie-like disease in caterpillars of the meal moth, described by Berliner in 1911, seems to begin with an acute intestinal disturbance which later affects the entire body, converting the interior into a brown liquid. In April, 1913, an article on Septicemia-like disease of caterpillars of *Arctia caja* L. appeared in the "Comptes Rendus des Séances de l'Académie des Sciences."

According to the authors Picard and Blanc, caterpillars dead from this disease become flaccid and give off a putrid odor. Their digestive tube is empty and contains a clear liquid often exempt from micro-organisms. The blood, however, contains a pure culture of what Picard and Blanc call a coccobacillus and with which they have artificially reproduced the disease. This coccobacillus for which they propose the name *Coccobacillus cajæ* measures about 1.5μ and is slightly oval. It is motile, and Gram negative but takes the anilin dyes readily. Cultures in bouillon grow in twelve hours at temperatures ranging from 15 degrees to 35 degrees, with an optimum growth at 25 degrees. The cultures have an odor resembling putrid eggs and in 24 hours assume a greenish fluorescent tint best obtained at the optimum growth temperature. The

cultures do not contain pyocyanin, however, as can be shown by extracting with chloroform. The coccobacillus grows rapidly on gelatine which it liquifies and on gélose (agar) the growth in two cases was slightly fluorescent. Streak cultures on gélose (agar) spread in a short time all over the surface. On potato the growth is feeble and begins to develop only after 48 hours without producing the greenish fluorescent pigment. Caterpillars of *Arctia caja* inoculated in the prolegs with a fine needle dipped in virulent blood or in a culture of bouillon die regularly in three days when kept at 15 degrees and present an intense multiplication of the bacillus in their blood. Inoculated caterpillars die in 12–24 hours when they are kept at a temperature of 25 degrees and the blood of such individuals appears more virulent than the blood of those which die at 15 degrees. If several drops of the culture are introduced into the pharynx by means of a pipette caterpillars die in 24 hours at 25 degrees and the coccobacilli invade the blood. This fact, that caterpillars can be infected by ingesting the etiological factor, leads the authors to hope for the employment of the disease practically.

Picard and Blanc found that brown-tail caterpillars are very susceptible to the coccobacillus. The authors inoculated several Coleoptera and Hemiptera, but found that the bacterium was non-pathogenic to these forms. White rats are also nonsusceptible to the intraperitoneal injection of a cubic centimeter of a virulent culture in bouillon, but the green frog (*Hyla arborea*) is susceptible and dies in 24–48 hours when inoculated in the lymphatic spaces. The blood from such a frog is again virulent for caterpillars.

The above results obtained by Picard and Blanc may have been correctly interpreted, but they can hardly expect bacteriologists to accept them for the following reasons: No account of their actual experiments is given; we know nothing about the number of caterpillars which were used, and no mention was made of controls. The absence of accurate controls alone places the article among worthless publications. Furthermore, the morphological description of their coccobacillus is very superficial and cultural features are almost entirely disregarded. They say nothing about colonies on nutrient gelatine or agar other than a growth was obtained on these media. Many other media absolutely essential

for a scientific treatment of the subject have been omitted. Apart from the pyocyanin test and the mention of temperatures all physical and biochemical characters have been ignored and the question which I would like to ask is: How do Picard and Blanc know that they were dealing with the same organism at all times?

Many of the authors reviewed seem to agree in one point, namely, that the flacherie-like diseases are primarily intestinal affections and that the bacteria concerned are found outside of the intestine, in the body cavity, only during the later stages when the alimentary canal ruptures.

Among certain human diseases somewhat analogous cases can be found. In typhoid fever, for instance, the main lesions of the disease occur in the intestine. Cholera is purely an intestinal affection characterized by diarrhœa in the form of the so-called rice water discharges. Among insects, European foul brood, a disease in bees caused by *Bacillus pluton*, is another example of such an intestinal malady.

While it therefore seems possible that some of the caterpillar diseases now grouped under the name of flacherie are intestinal disturbances caused by toxic products liberated within the alimentary tract by specific bacteria, it is not at all unlikely that other diseases affect other parts of the body such as the disease described by Picard and Blanc. The entire subject, however, is still one for controversy.

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SOME MYRMECOPHILOUS INSECTS FROM MEXICO

By W. M. MANN

[Reprinted from Psyche, Vol. XXI, No. 6]

SOME MYRMECOPHILOUS INSECTS FROM MEXICO.[1]

By W. M. Mann.

The following notes are based on a small collection made during the months of May, June and July, 1913, in the State of Hildalgo, Mexico. Most of this time was spent at the Guerrero Mill, located below Real del Monte, and at the Hacienda de Velasco, where I was the guest of Mr. and Mrs. C. W. Van Law. They, together with the other Americans and English in charge of the mines and mills, showed me every hospitality and it is largely due to them that I was able to reside and collect in this interesting locality. I am much indebted to Miss Helen L. Locke, Mr. and Mrs. J. H. Skews and Messrs. Broiderick, Benton, Funston and Calland, not only for assistance of various kinds, but for many desirable specimens which they collected. The material collected has been placed in the collections of the Museum of Comparative Zoölogy at Cambridge and of Mr. B. Preston Clark of Boston, through the kindness of whom the excursion was possible.

Although this region is easily accessible, and unusually interesting and rich in insect life because of its ecologically varied nature, it has been largely neglected by collectors. Only a few things have been collected at Pachuca and at Guerrero Mill. Prof. W. M. Wheeler, in looking over the literature on Mexican ants, failed to find Hidalgo cited as the locality for a single species, and I have found no records of other insects from that state.

Among the thirty-nine species and varieties of ants collected (an account of these has been published by Wheeler in the *Journal of the New York Entomological Society*, Vol. XXII, 1914, pp. 37–61) nine were found to harbor guests or parasites. Three of these belong to the genus Formica, one each to Camponotus, Prenolepis,

[1] Contribution from the Entomological Laboratory of the Bussey Institution of Harvard University, No. 84.

Liometopum and Tapinoma, and two to Pheidole, all of which genera are commonly the hosts of inquilines, Prenolepis less frequently than the others. The inquilines found are mostly undescribed species of genera known to be of myrmecophilous habits, but a new Diaprid, *Hemilexis jessei*, and a new genus of Bethylidæ, *Bruesiella formicaria*, both of which are probably parasitic on the host ant, are described. There is also an interesting new genus of cockroach, *Myrmecoblatta rehni*, which inhabits nests of various species of ants, where it no doubt officiates as scavenger. The occurrence of the weevil *Liometophilus manni* Fall at Pachuca, with the same species of host with which it has been found in Arizona shows that it is definitely associated with this ant.

I have included in this paper a few remarks on the synonomy of some species from north of the Mexican boundary, and erected a new subgenus to contain certain of our species of Cremastocheilus.

ORTHOPTERA.

Family Blattidæ.

Subfamily BLATTINÆ.

Myrmecoblatta gen. nov.

Female: Body elongate oval, not greatly flattened, the abdomen about as broad as the thorax. Head almost concealed by the pronotum, only a narrow strip of the vertex showing. Head small, triangular, the vertex somewhat swollen. Eyes well developed, elongate, emarginate on inner border. Antennæ long and slender, the first joint thickened, the second small, the third longer than the second and twice the length of the fourth. Thorax longer than broad, convex above, tegmina and wings absent. Abdomen convex above, beneath gradually elevated to the middle, which is therefore broadly carinate. Supra-anal plate semi-orbicular, evenly rounded in outline. Cerci large, with eight distinct joints. Sub-genital plate apparently provided with valves. Last ventral segment completely divided by a V-shaped slit. Legs short and robust, with abundant fine, short hairs. Femora weakly armed beneath, and with a strong spine at apex; tibiæ spined at apex and on outer margin.

Male: Form broad. Pronotum entirely concealing the head. Tegmina more than half as broad as long; short, not reaching apex of abdomen, with poorly developed veins. Wings short and broad, less than half the length of tegmina, with poorly developed veins. Supra-anal plate more than twice as long as broad, the sides concave in outline, posterior border notched at middle, rounded on either side. Sub-genital plate broader than long, straight at sides, rounded behind, slightly concave at middle, bearing two equal stylets.

Type: Myrmecoblatta rehni sp. nov.

Myrmecoblatta rehni sp. nov.

Female: (Fig. 1). Length 5 mm. Width 3 mm. Color reddish-brown, the legs lighter, above regularly punctate and finely setose. Thorax longer than broad. Pronotum broader than long, with concave posterior border and extended, narrowly rounded angles. Meso-and epinota subequal, with nearly straight sides and concave posterior border. Abdominal segments 1–7 subequal, with straight posterior borders, the eighth considerably narrower than the seventh, rounded behind. Cerci 8-jointed, a third as broad as long, acuminate for apical half their length; nearly as long as the sub-genital plate. Head about as broad as long, the front with an indistinct Y-shaped suture. Labium obtusely pointed, concealing the mandibles. Eyes occupying the sides of the head, faintly emarginate on the inner border. Antennæ slender, shorter than the body, about 37-jointed; the third joint twice as long as the fourth, joints 4–13 transverse, the rest distinctly longer than broad, and sub equal; all the joints finely setose. Legs short, rather flat, the femora armed at apex with a slender curved spine; tibiæ bearing on the outer border three slender subequal spines, at the apex two long and two shorter spines.

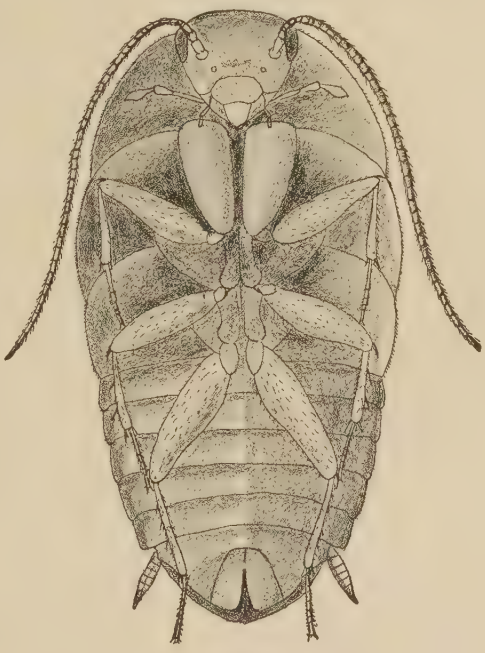

Fig. 1. *Myrmecoblatta rehni* gen. & sp. nov. Ventral surface of female.

Male: (Fig. 2). Length 4.5 mm. Width 2 mm. Color and setosity similar to that of female. Pronotum proportionally slightly broader than in the female, the angles broadly rounded, posterior border concave. Tegmina extending a little more than two-thirds the length of abdomen, broadly oval in outline, the apex narrowly rounded; venation not very distinct. Wings less than half the length of tegmina. Cerci

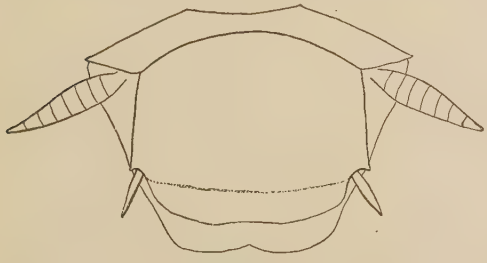

Fig. 2. *Myrmecoblatta rehni* gen. & sp. nov. Ventral surface of last gastric segments of male.

more slender than in the female, longer than the supra-anal plate at middle. Legs and antennæ longer than in the female, the latter as long as the body.

Nymph: Similar to female, lighter in color. The suture on the front of head is more distinct than in the adult.

Described from one male and numerous females and nymphs taken at Guerrero Mill in nests of *Formica subcyanea* Wheeler, *F. rufibarbis* Fab. var. *gnava* Buckley, and *Camponotus maculatus* Fab. subsp. *picipes* Olivier. Some of the females had oöthecæ attached. They were abundant, several occurring in almost every nest, where they are no doubt very efficient scavengers. The genus has no systematic affinities with *Attaphila*, the only other known Blattid of Myrmecophilous habits, but is more closely related to Blatta, to which it runs in Caudell's key to the genera of this family (*Proc. U. S. Nat. Mus.* Vol. 44, 1913, p. 601–602).

COLEOPTERA.

Family Staphylinidæ.

Pseudolomechusa subgen. nov.

Type: *Xenodusa sharpi* Wasmann.

This beetle was described by Wasmann from a series which were taken at Cuernavaca, in company with *Camponotus auricomus* Roger. In one canyon near the Guerrero Mill I found a number of adults, some of them in copula, with colonies of *Camponotus maculatus* var. *picipes*, Olivier which was here very abundant. In the immediate vicinity were many nests of *Formica microgyna rasilis* var. *nahua* Wheeler and several of *T. rufibarbis* var. *gnava*. Buckley. With the former ant three adults of *sharpi* were taken and with *gnava* several more, and three larvæ, the latter close to the ant brood. As most of the beetles were found with *C. picipes* (nineteen were taken from one nest) it appears that this is the secondary or winter host and *F. gnava* the primary or definitive. This heterocious habit is common to all of our species of *Xenodusa* as far as known. The adult *sharpi* is very different from the other American species on account of its greatly thickened pronotal margins and shorter antennal joints. Seen in profile the anterior border is drawn out beneath into a distinct angle similar to the structure in the species of the European genus Lomechusa.

The larva is very different from that of *X. cava*, the only one known in that stage, which has been described and figured by Wheeler (*Jour. N. Y. Ent. Soc.*, Vol. XIX, 1911, p. 165–166) and closely resembles that of Lomechusa. Those which I found are 5.5 mm. in length, yellowish-white in color, with short, feeble legs, no eyes, papillose antennæ and shallowly impressed vertex. The body is slender and cylindrical, not at all depressed as it is in *cava*, with an even covering of fine erect hairs.

The movements in life were very slow. Considering the pronotal structure and the larval characters *sharpi* should not be included in Xenodusa sens. strict., but more properly belongs to a distinct subgenus for which I propose the name *Pseudolomechusa*.

Apteronina wasmanni sp. nov.

Length 3 mm. Head broader than long, rounded at sides, occipital margin straight; clypeus projecting, the anterior border rounded; front broadly depressed, the surface concave, with a longitudinal impression extending to occiput. Eyes rather large, located at sides of the anterior third of head. Antennæ long, the first joint about twice the length of the second, which is two-thirds as long as the third; the second joint is sharply constricted near base; fourth joint about half as long as third; joints 4–10 subequal in length, becoming thicker anteriorly; apical joint cylindrical, nearly twice the length of penultimate. Thorax not as broad as head, very slightly longer than broad, rounded in front and at anterior third of sides, posterior to which the sides are straight; posterior border straight; surface slightly concave, with a narrow longitudinal impression at middle. Elytra transverse, each as long as broad, together broader than thorax; sides nearly straight; posterior border rounded. Abdomen at base as broad as elytra, broadest behind. Legs long and slender.

Body and legs subopaque, finely punctate, the punctures coarser on the elytra and abdomen; everywhere with fine, recumbant, silky hairs; thorax and sides of abdomen with longer coarse hairs.

Color black, the antennæ and legs brownish.

Described from several specimens taken with *Liometopum apiculatum* Mayr at Pachuca and Guerrero Mill.

A. schmitti Wasmann, which lives in company with the same host ant from Colorado to Southern Arizona, has the head longer than broad, the thorax is longer in proportion to the width, the general form is more slender; the color is light ferruginous, except the gaster, which is dark fuscous. The color of the Mexican form of the host ant is considerably darker than that of the Arizona variety with which I have taken *schmitti*, so the beetle in each

case resembles the ant in that respect. Besides color the beetle is similar to the host in pilosity and, superficially, in form, and in life it carries its abdomen erect in a manner similar to the way in which the ant holds its gaster. Nothing is known regarding the biological relation of the beetle to the ant.

Dinardella mexicana sp. nov.

Length 2.75 mm. Head slightly broader than long, rounded at sides and in front, posterior border straight; front with a flattened disc. Eyes medium in size, flat. Antennæ short, extending to apex of elytra; joints in front of the middle thickest; first joint as long as the two succeeding together; joints 2–3 longer than broad; joints 4–10 transverse; apical joint a little less than twice the length of penultimate. Prothorax as long as broad, broadest at posterior fourth, posterior to which the sides are straight; anterior and posterior borders straight; disc with a faint longitudinal impression. Elytra transverse at base, together considerably broader than thorax; sides slightly rounded; the posterior border of each straight. Abdomen broad and flat; at base as broad as elytra, the greatest width at the third and fourth segments. Legs short and slender.

Body subshining, finely punctate throughout and covered with a fine mat of yellow pubescence; the thorax and elytra bear scattered, erect, black hairs.

Color dark fuscous to piceous, legs and antennæ lighter.

Described from a small series taken at Pachuca and Guerrero Mill with *Liometopum apiculatum* Mayr.

Besides being much darker in color *D. mexicana* differs from *D. liometopi* Wasmann in the shape of the head, which in the latter species is distinctly triangular and much broader than long; in the thorax not being broader than long, and in having proportionately longer elytra.

Zyras (*Myrmœcia*) **tapinomatis** sp. nov.

Length 3 mm. Thorax broad; abdomen narrow. Color piceous, except the antennæ, mandibles, palpi and tarsi, which are fuscous; shining throughout; the antennæ less so than the body. Head not as wide as prothorax, about as long as broad; finely but distinctly punctate. Antennæ not extending to apex of elytra, thick; first and third joints longer than broad, second joint small; joints 4–10 as long as broad, each slightly longer than the preceding; apical joint a little shorter than the next two together. Pronotum a little broader than long, with rounded sides, the disc at middle very broadly and deeply impressed, the impression about one and a half times as long as broad; finely punctate. Elytra together broader than long, the sides straight and parallel, punctured similar to pronotum. Abdomen long and slender; about two-thirds as broad as elytra; very shining; the third and fourth segments each having on the dorsum a prominent tubercle, the anterior of which is the smallest, conical, and bears at the sides a fine mat of re-

cumbent yellow hairs; the posterior from above is round, with flat surface and without hairs. The median portion of the abdominal dorsum is glabrous; the rest of the body, legs and antennæ are thickly though microscopically pilose, the antennæ more densely than the other parts.

Described from three specimens taken at San Miguel in nests of *Tapinoma sessile* Say.

This species is very similar to *M. lugubris* Casey which I took some years ago in Orcus Island (Puget Sound) with colonies of the same host ant, but differs in the fine punctation of the head and thorax, which in *lugubris* are reticulate. The thoracic depression in *tapinomatis* is deeper and narrower than in *lugubris* and the abdomen is proportionally much more slender.

Family Pselaphidæ.

Pilopius major sp. nov.

Female: Length 3.25 mm. Color throughout brown. Head narrower than thorax; from the front twice as long as broad, the sides in front of eyes sub-parallel; vertex foveolately impressed at sides, a thin median carina extending to between the antennal tubercles. Eyes large and convex, located at the posterior third of head. Antennæ thick, the first joint slightly bent at base, as long as the two succeeding joints together; third joint smaller than the fourth, which is larger than the fifth; joints 5–11 sub-globose, equal in size; apical joint one and three-fourths times as long as penultimate, thickened. Prothorax a little longer than broad, narrowed in front, with rounded sides; base compressed above, with median and lateral foveæ; the former is elongate, extending one-third the distance to apex. Elytra together longer than broad, the sides rounded; humeri elevated into thick ridges; discal striæ broad, slightly arcuate, extending three-fourths the length of elytra. Abdomen narrower than elytra and about the same length.

Body shining everywhere, finely punctate, with a thin covering of short, scale-like hairs which are more dense in the pronatal foveæ and on the occiput and posterior elytral margins.

Described from specimens taken at San Miguel with *Prenolepis* (*Nylanderia*) *mexicana* Forel., one from each of three colonies. The maxillary palpi are short and proportionally smaller than in the other species of the genus that I have seen. This species belongs to the group which includes *pulvereus* Lec., *ocularis* Csy. and *abruptus* Csy., in the latter two of which only the males have been described, but is considerably larger than any of these. The pubescence is much sparser than in *pulverius*. The other species whose hosts are known are guests of different species of Aphæno-

gaster. Like most other Pselaphids of myrmecophilous habits, few are found in a single ant colony, but they are generally common, there being one or two in almost every nest of the host ant in the localities where they occur.

Family Histeridæ.

Hetærius helenæ sp. nov.

Length 2 mm. Color reddish-brown, in some specimens the side margins of the head, the margin of mandible and apex of femur piceous; shining. Form robust, about two-thirds as broad as long. Head above sparsely, coarsely punctate, less so between the eyes and beneath; clypeus about twice as broad as long, finely punctate; front with short yellow hairs. Thorax transverse, its breadth nearly twice the length; broadest at base; front border concave, narrowly margined; sides straight to the constriction, which is located about five-eighths the distance from the anterior angle to base; median portion of disc finely, regularly punctate, with sparse yellow hairs; marginal portion in front of constriction very finely rugose longitudinally and less shining than the remainder of thorax; the anterior border feebly rounded, posterior portion slightly elevated; margin of sides with a rather dense brush of long stiff yellow hairs. Elytra at base distinctly broader than thorax, the width of both together about equal to length; abundantly pilose; apical margin punctate; marginal and humeral striæ entire; third and fourth striæ extending for five-sixths the length of elytra, carinated for entire length. Propygidium and pygidium finely rugulose, the former with sparse long hairs. Posternum narrowly margined for half its length; transversely impressed at half the distance from end of margination to anterior border; distinctly excised at anterior border; margined portion shining, smooth behind and finely punctate in front. Anterior tibiæ nearly a third as broad as long, the front margin posterior to the angle straight, with about eleven elongate denticles. Middle and posterior tibiæ one-third as broad as long, the outer edge rounded.

There is considerable variation in the shade of color and a little in size. The hairs are rather long, curved, and moderately abundant. In some specimens they are almost entirely absent, probably having been scraped off by the ants.

Described from a number of specimens taken in nests of *Formica subcyanea* Wheeler and *F. microgyna* subsp. *rasilis* var. *nahua* Wheeler. The former ant is the favorite host, as nearly every nest in some localities contained the beetles, while they were found in only one nest of the latter species out of dozens examined.

This species, the first known from Mexico, is more closely related to some undescribed forms from our southwestern states than to any of the described species. It is more pilose than any of the species which I have seen, except *californicus* and an undescribed species (*hirsutus mss.*) from Arizona.

Terapus mnizechi Mars.

Two specimens were taken at San Miguel in nests of *Pheidole vasleti* var. *acolhua* Wheeler. In the place where these were found was a stone fence extending for about a half mile, along which were literally hundreds of nests of *acolhua*. Although I made several visits here and searched many nests in other localities for the beetles no more were found. It is evidently exceedingly rare locally but has a wide distribution in Mexico.

Terapus infernalis Fall.

Melanetærius infernalis Fall.

An account of this species has been given by Wheeler (PSYCHE XVIII, 1911, p. 112–114) who found a number of specimens at Pasadena in company with *Pheidole hyatti* Emery. One of these was studied by Bickhardt (PSYCHE XIX, p. 97, 1912) who found that the beetle and most of the details of Wheeler's figure agreed with Marseul's description and figure of *mnizechi*, to which species he referred it. Recently, through the kindness of Mr. J. H. Arrow, I was able to examine in the British Museum a specimen of *mnizechi* from the Federal District of Mexico. This was undoubtedly the same as the San Miguel specimens, and these are specifically quite distinct from the Southern California form. In *infernalis* the propygidium is feebly punctate above and more coarsely beneath, with the upper, smoother portion much smaller than the lower, and there is no sharp line between the two parts. In *mnizechi* the upper portion is smooth and shining, the lower punctured and opaque, and each part is in strong contrast to the other. The upper part is proportionally larger than it is in *infernalis*. The latter species is smaller, measuring two millimeters while *mnizechi* measures three.

Family SCARABÆIDÆ.

Cremastocheilus, *subgenus* **Myrmecoecus** nov.

Type: *Cremastocheilus knochii* Lec.

I propose this subgenus to contain those species which have the mentum angulate behind. This character is correlated with the geographical distribution of the species, all of the species in this group inhabiting the middle and far West. *C. wheeleri* Lec.

should be included with these, though in some specimens the mentum is very feebly notched.

The species which belong to *Cremastocheilus* subgenus *Cremastocheilus* have the mentum distinctly incised behind and are all native of the Atlantic states. The type of the genus *Cremastocheilus* is C. *castaneæ* Knoch.

Cremastocheilus (Myrmecocconus) mexicanus West.

Several specimens, found with *Formica subcyanea* Wheeler at Guerrero Mill agree closely with others identified as this species from nests of *Formica gnava* Buckley in the Huachuca Mts. (Schaeffer) and from the Santa Rita Mts., Arizona (Snow). There is in this series, as in other species in the genus, considerable variation in sculpture and pilosity as well as in size.

Cremastocheilus (Myrmecocconus) armatus Walker.

C. pilisicollis Horn.

Recently I examined the type and several paratypes of *C. armatus* in the British Museum, and compared with specimens of the form which is identified in collections as *pilisicollis* Horn. The two are identical, so the latter name must fall into synonomy, as was considered probable by Horn. (Monographic Revision of the species of Cremastocheilus and Synopsis of the Euphoriæ of the United States. *Proc. Amer. Phil. Soc.* XVIII, 1879, p. 390).

Family Curculionidæ.

Liometophilus manni Fall.

A single specimen of this curious weevil was taken at Pachuca in the galleries of a colony of *Liometopum apiculatum* Mayr. The species was first found in Southern Arizona, where it lives with a variety of the same ant. The oily-red color, so characteristic of the chitin in many beetles of myrmecophilous habits, is evident at the middle of the anterior elytral margin, where the scales are absent, probably having been gnawed off by the ants. This is, so far as is known, the only truly myrmecophilous weevil found in North America.

The Mexican specimen (length 4 mm.) is considerably larger than a paratype from Arizona in my collection, and the light-

colored transverse bands on the elytra are in stronger contrast to the rest of the body, but otherwise the two agree closely.

HYMENOPTERA.

Family Diapridæ.

Hemilexis jessei sp. nov.

Female: (Fig. 3). Length 3 mm. Color jet black, except the mandibles, front of the propleuræ, petiole, antennæ and legs, which are rufous. Head subglobose, as broad as long and about as thick as long, sparsely punctulate, with scattered white pilosity; occipital border rounded, sides in front of eyes very slightly concave. Mandibles thick and short; bifid at tip. Eyes large, orbicular, little convex, black, located at sides of head posterior to middle. Ocelli small, arranged in a triangle. Antennæ inserted at bases of flattened tubercles; contiguous at base; the scape clavate, about as long as head; apex of scape shortly excavated beneath, unarmed. Pedicel thickened toward apex, as long as the first funicular joint; first funicular joint a little longer than the second, joints 2–6 subequal; the last four subequal, forming a club. Prothorax above very short; in profile triangular; the pronotum thickly covered with white pubescence. Parapsidal furrows shallow, but distinct, extending the length of mesonotum. Mesonotum feebly, very sparsely punctate. Scutellum sparsely rugulose longitudinally, transversely

Fig. 3. *Hemilexis jessei* sp. nov. ♀

depressed posteriorly. Metanotum longitudinally carinate at middle, the surface rugulose. Petiole cylindrical, twice as long as broad, smooth and shining. Abdomen smooth and very shining; somewhat depressed. Legs rather short, the femora narrow basally, and clavate at apex. Wings extending past tip of abdomen, the tips rounded; pilose; slightly infuscated; veins yellowish.

Described from a series found in several colonies of *Formica subcyanea* Wheeler about Velasco and near Guerrero Mill. This is the second American species of Hemilexis as defined by Kieffer (*Gen. Ins. Fasc.* 124, p. 20, 1911), and differs widely from the other, *H. californica* Ashmead. Nothing is known regarding the habits of the other species, but *jessei* and the following variety are undoubtedly closely associated with the ants, probably as parasites on the immature phases. Only one or two individuals were found in each nest. They moved about rather slowly among the ants, which paid no attention to them.

This species is dedicated to my small collecting companion, Master Jesse Van Law.

Hemilexis jessei var. minor var. nov.

Three females which were taken in the same locality and with the same host ant as the preceding form seem to belong to a distinct variety. The size is much smaller (length 1.75 mm.) than in the typical form, and the coloration is lighter. The prothoracic pleuræ, scutellum and petiole being light fuscus. Otherwise the two forms are identical.

Family Bethylidæ.

Bruesiella gen. nov.

Female. Apterous. Head transverse, broader than thorax; face evenly rounded, smooth except small foveæ at apex. Antennæ 12-jointed, the basal joint much enlarged; inserted at base of clypeus; narrowly separated at base. Mandibles stout, thickened at tips. Eyes well developed, oval, flat. Ocelli absent. Prothorax transverse, smooth, with a single large puncture near a feeble longitudinal impression at margin. Mesothorax transverse, the pleuræ extended into a thick, nearly perpendicular lamina. Metanotum from above subquadrate, broadest behind, sides feebly, irregularly margined; the posterior border with an acute, interrupted carina. Scutellum absent. Abdomen slender, somewhat depressed. Legs short, stout, the middle and posterior femora swollen, flattened; tibiæ spinose, the middle more strongly than the others.

This genus runs out at Sclerochroa in Kieffer's table in the Genera Insectorum. (Fascicle 76, p. 10, 1908). The peculiar structure of the mesothorax is quite different from that in any other of the described allied genera. In general appearance it bears considerable resemblance to some of the Thynnidæ.

Type: Bruesiella formicaria sp. nov.

Bruesiella formicaria sp. nov.

Female: (Fig. 4). Length 3.5 mm. Body shining. Head, thorax, anterior portion of first abdominal segment and legs brown, remainder of abdomen black.

Head much broader than long, with straight sides, rounded posterior corners and straight posterior border. Clypeus broadly rounded in front. Mandibles slender, curved; the tip thick. Eyes large and flat, located in front near sides at about half their length from base of clypeus. Ocelli absent. Antennæ 12-jointed, short and thick, the first joint swollen, as long as the second and third together; second joint shorter than third, joints 3–11 subequal, cylindrical, longer than broad; apical joint about twice as long as penultinate. Head and antennæ shining, minutely punctate, the vertex with four distinct foveæ arranged trapezoidally. Prothorax transverse, narrowed in front to form a short, thick neck, sides slightlyrounded; posterior border concave. Mesothorax transverse, flat above; the pleuræ extended into broad, vertical lamellæ, which incline slightly backward toward the base. Metanotum narrower than mesonotum, longer than broad, widest behind; depressed at middle, the posterior border acutely carinate; posterior surface flat. Abdomen with a short thick petiole; a little longer than head and thorax, subcylindrical. Legs stout, the femora enlarged, flattened, middle tibiæ with five strong spines on outer edge. The entire body with very sparse scattered erect, black hairs, tarsal joints spinose at apex.

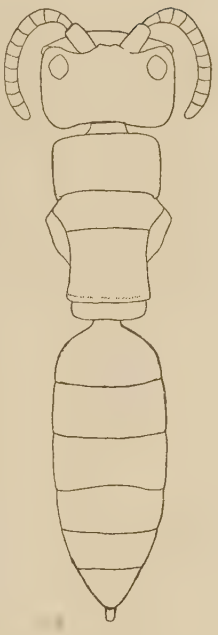

Fig. 4.
Bruesiella formicaria gen. & sp. nov. ♀

Described from a single specimen taken with *Formica microgyna rasilis* var. *nahua* Wheeler at Guerrero Mill.

Family Pteromalidæ.

Pheidoloxenus wheeleri Ashmead.

A single specimen of this wingless parasite was found with *Pheidole ceres* Wheeler var. *tepaneca* Wheeler at Guerrero Mill. Wheeler, who discovered the species in nests of *Pheidole instabilis* in Texas, considered that it is entoparasitic, either on the ants or their brood.

Family Eucharidæ.

Orasema tolteca sp. nov.

Female: Length 4 mm. Head triangular, slightly longer than broad, with convex occipital border and nearly straight sides. Mandibles bidentate, the teeth long and acuminate; front flat; clypeus and frontal area separated from the remainder of front by a deep impression. Eyes oval, large, very convex; ocelli large and

convex, arranged in a broad triangle. Antennæ short and stout, the funiculus extending barely to occipital border; pedicel slightly longer than thick; funicular joints subequal, cylindrical, one and one-third times as long as broad; apical joint conical, one and one-half times the length of penultimate. Thorax trilobed, lobes convex. Scutellum rounded behind, with a strong transverse impression before the posterior border. Metanotum abruptly sloping, with strong lateral sulci. Petiole from side more than twice as long as thick.

Head shining, finely densely punctuate, the temples finely shagreened; flagellum coarsely punctate and opaque. Thorax and petiole coarsely, densely, rugosely punctate; parapsides finely, transversely aciculate; gaster smooth and shining. Scape brown at base, flagellum black, tips of femora, the tibiæ and tarsi ferruginous; rest of body metallic green. Wings slightly infuscated, veins and the distinct stigma brown.

Male: Similar to the female. The thorax is bronze in color, and the petiole proportionally thicker.

One male and two females, together with numerous pupæ were found at San Miguel in nests of *Pheidole vasleti* var. *acohlma*. The pupæ were lying among the brood of the ants, and were always quickly removed by the worker ants when the nest was uncovered.

This species is much larger than *O. occidentalis* Ashmead, from Southern California, but is otherwise very similar. *O. stramineipes* Cameron, from Panama differs in the form of the metanotum which has: "a central area bordered by keels which sharply converge at the top." This is entirely different to the structure of the metanotum in *tolteca*.

A PRELIMINARY LIST OF INSECTS WHICH HAVE WILT, WITH A COMPARATIVE STUDY OF THEIR POLYHEDRA

By J. W. CHAPMAN and R. W. GLASER

[Reprinted from the Journal of Economic Entomology, Vol. 8, No. 1, 1915]

A PRELIMINARY LIST OF INSECTS WHICH HAVE WILT, WITH A COMPARATIVE STUDY OF THEIR POLYHEDRA[1]

By J. W. Chapman and R. W. Glaser

I. Description of Wilt

Although the nature of wilt in the gipsy moth will be thoroughly discussed by Glaser in a paper soon to be published, a restatement of its recognizable characteristics is necessary for a complete understanding of the discussion which is to follow; also because many persons are of the belief that wilt is peculiar to gipsy moth caterpillars only.

Clinical Picture

The wilt is characterized by the formation in the bodies of infected caterpillars of polyhedral-shaped, highly refractive, angular bodies, which have their origin in the nuclei of the tracheal matrix, hypodermal cells, fat cells and blood corpuscles. Later some of these burst and the polyhedra are set free in the blood. When death results they make up a great part of the saponified body tissues of the caterpillars. The caterpillars hang by their prolegs, become flaccid and their skin disrupts at the slightest touch. An examination immediately after death reveals few or no bacteria and no bad odor. The wilt appears in nature in both a chronic and an acute form. If, however, a dead caterpillar, on microscopic examination, shows no polyhedra it does not have wilt, even though all the gross symptoms may be present.

The point we wish to emphasize is that a consideration of both the external characteristics and the polyhedra is essential to a complete diagnosis of isolated or chronic cases of wilt; because there are a number of diseases of caterpillars, such as fungous, protozoan and possibly bacterial diseases, with which it might easily be confused under such conditions, even by the most experienced. If on the other hand the wilt has reached the epidemic form, it is highly improbable that it could be confused with anything else.

Following this rule of diagnosis we should look for wilt in all forms of insect life; for where it was thought to be rare it has proven to be common and widely distributed as will be seen from the following insects reported to be affected by it. For convenience of discussion and to prevent possible confusion we have divided them into three groups.

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[1] Contribution from the Bureau of Entomology in coöperation with the Bussey Institution of Harvard University. (Bussey Institution No. 85.)

Group A contains, with the exception of the silkworm, the insects we have studied. Six families and ten species are represented.

Group B contains a list of insects reported to have polyhedral-sickness by the European investigators, Prowazek, Escherich, Wahl, Bolle, Bohm, etc.

Group C is made up of insects found in the United States that have a disease or diseases similar to wilt in many of its clinical aspects. With the exception of *Colias philodice* none of this group have been examined by us.

List of Species, with Their Distribution

Group A

I. Saturnidæ.
1. *Hemileuca olivia* Ckll.

II. Noctuidæ.
2. *Leucania unipuncta* Haw.
3. *Laphygma frugiperda* S. & A.

III. Dioptidæ.
4. *Phryganidia californica* Packard.

IV. Lymantriidæ.
5. *Porthetria dispar* L.
6. *Lymantria monacha* L.
7. *Orgyia leucostigma* A. & S.

V. Lasiocampidæ.
8. *Malacosoma americanum* Fabr.
9. *Malacosoma disstria* Hübner.

VI. Bombycidæ.
10. *Bombyx mori* L.

Group B

I. Sphingidæ.
11. *Deilephila* sp.
12. *Smerinthus atlanticus* Auct.

II. Saturnidæ.
13. *Antherea pernyi* Guer.
14. *Antherea yama* Guer.
15. *Antherea mylitta* Drur.
16. *Philosamia cynthia* Drur.
17. *Saturnia pavonia major* O.

III. Noctuidæ.
18. *Prodenia litosia*

IV. Lymantriidæ.
19. *Orgyia antiqua* L.

V. Notodontidæ.
20. *Harpyia bifida* Hubn.

VI. Geometridæ.
21. *Bupalus piniarius* L.

VII. Tortricidæ.
22. *Conchylis ambiguella* Hubn.

VIII. Tenthredinidæ.
23. *Lophyrus rufus* Ratz.

IX. Muscidæ.
24. *Calliphora vomitoria* L.

X. Dermestidæ.
25. *Dermestes lardarius* L.
26. *Anthrenus musœorum* L.

Group C

I. Pieridæ.
27. *Colias philodice* Godart.
28. *Eurymus eurytheme* Boisd.

II. Arctiidæ.
29. *Hyphantria cunea* Drury.

III. Noctuidæ.
30. *Alabama argillacea* Hubn.
31. *Heliothis obsoleta* Fab.
32. *Autographa gamma californica* Speyer.
33. *Autographa brassicæ* Riley[1]

IV. Notodontidæ.
34. *Heterocampa guttivitta* Wlk.

[1] January 23, 1915. Polyhedra were found in a caterpillar of *Autographa brassicæ* Riley during the past week.

Distribution—Group A

One of the most interesting phases of wilt besides its occurrence in so many widely different species, is its geographical distribution. We have already called attention (Dec., 1913) to its almost general occurrence in the Nun moth caterpillars and silkworm in Europe, where it is commonly known as "Polyederkrankheit" or polyhedral sickness.

The Gipsy Moth

Glaser (1915) has shown that the wilt is present throughout the entire gipsy moth infested area in New England.

Apple Tent Caterpillar

Observations on the tent caterpillars which we also previously reported have not been so general as those of the gipsy moth. However, more attention was given to them the past summer and one point in particular, near Lunenburg, Mass., was kept under observation. This was one of the gipsy moth observation points and consisted of a tract of mixed forest of perhaps fifty acres, surrounded by a dense swampy growth of many acres in extent. It was in this low growth that the apple tent caterpillars suffered almost complete annihilation from wilt. It first appeared in a chronic form, a few dying here and there in the webs. These would sometimes be spun over by the remainder of the colony before others died. It became epidemic about the time of complete defoliation (May 28–31, 1914), and within a few days thousands of webs were covered with dead and dying caterpillars, most of which were distinctly strawberry red in color. We searched this area for living caterpillars at this time and only a few were found. All of these when examined showed polyhedra in their blood. They too died in a few days.

Forest Tent Caterpillar

Though the wilt was also reported to have occurred in many places in the Forest Tent caterpillar, neither of us have seen more than a few typical cases from the field. Many caterpillars were sent in by the field men but only a few of them proved to have typical wilt.

The Army Worm

An outbreak of the army worm on Long Island, Boston Harbor, during August, gave us an opportunity to determine if wilt also occurred in that species. A trip was made to the Island through the courtesy of the officers of the penal institution of the city. Several hundred caterpillars were collected. Nothing resembling wilt was seen at the

time though many were dead or dying. The next day a typical case of wilt developed in one of the stock trays in the laboratory. The caterpillar was flaccid, hung by its prolegs and the skin broke at the slightest touch. A thin grayish liquid oozed out which proved on examination to contain almost pure polyhedra. Other cases of wilt developed in these trays from time to time. A number of deaths were also caused by bacterial infection as the post-mortem examinations showed.

We have had shipments of army worms from Nantasket, Mass., Hagerstown, Md., and Norfolk, Va. That the wilt was present in all of these places was shown by the typical cases of wilt in the shipping boxes at the time of their arrival at the laboratory from these places. J. A. Hyslop, of the Bureau of Entomology, who is located in Maryland, shipped 350 caterpillars (isolated in separate pill boxes) at one time. These were from seven different broods. Brood number five had 52 caterpillars, 50 of which were dead when we received the shipment. The remaining two died before the next day. There were also 30 dead in the other six broods, making a total of 82 dead with wilt out of 350 caterpillars.

Prof. Franklin Sherman, Jr., of North Carolina, recently informed us, after we had described the wilt to him, that some such malady did a great deal towards checking an outbreak of the army worm in North Carolina the past summer.

We have been more recently informed concerning the appearance of the wilt in two other outbreaks of the army worm, one in Illinois and the other in Oklahoma.

The Tussock Moth

During 1911 we made observations on the Tussock moth on Boston Common. A disease appeared among the second generation caterpillars which almost completely destroyed them. It had all of the external appearances of wilt and was so considered by us at that time, though no microscopical examination of the caterpillars was made.

The Tussock moth has been so scarce in New England since then that we have been unable to verify the observations of 1911.[1] The abun-

[1] Since the above was written we found some of the dried Tussock moth caterpillars taken on Boston Common, Aug., 1911, which had been stored with other insect materials. We examined them and the polyhedra were found to be plentiful and as fresh in appearance as though they came from caterpillars of the past season.

December 22, 1914, we received a letter from J. S. Houser, Associate Entomologist at the Agricultural Experiment Station, Wooster, Ohio, in which he says of *O. leucostigma:* "The accompanying photograph was taken July 7 at the time the caterpillars were supposed to be transforming to the pupal stage. The plot was practically defoliated, and for this reason attracted my attention; but much to my surprise I was

dance of this insect the past summer in Washington, D. C., provided the longed-for opportunity. Mr. E. R. Sasscer, of the Bureau of Entomology, kindly consented to send us caterpillars. About five hundred second generation caterpillars arrived from him the latter part of August. Beyond a few crushed in transit they appeared healthy and in good condition. Attached to some leaves which had served as food were two first generation pupæ which had failed to mature. These were examined and found to be full of polyhedra. Two days later a caterpillar was found dead, hanging by the prolegs. When grasped by a pair of forceps, its prolegs were left clinging to the side of the box. The case was as typical as any we had seen in the gipsy moth and the polyhedra were just as plentiful. A few of these caterpillars died each day until less than one dozen pupated out of more than five hundred caterpillars.

The Oak Caterpillar, Phryganidia californica

Early last spring we received word from one of Professor Kellogg's students at Stanford saying, "The Oak caterpillars are dying with a disease similar to wilt." We wrote him for material which he kindly sent; and though in poor condition when we received it, we were able to confirm his observations. Polyhedra were found in abundance in the dead caterpillars. According to his description of the disease it completely controls this pest at times and like wilt does the most good when defoliation has almost taken place.

The Range Caterpillar

Mr. H. E. Smith of the division of Cereal and Forage investigation has, the past summer, been working on the Tachinid parasites of the range caterpillar at the Melrose Highlands Laboratory.

On learning that we had found the wilt in other species of caterpillars besides the gipsy moth, he sent us a few Range moth caterpillars, one of which showed typical wilt symptoms. It proved on examination to be a very typical case. Since this was the last of his stock we have not had an opportunity to examine others, and therefore cannot say whether the wilt occurs naturally in the field or not. We will have to wait another season to determine this point.

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unable to find any pupæ. Upon examination, the dead caterpillars were found everywhere clinging to the branches, and also occurring in great abundance on the ground beneath. Some few caterpillars were yet alive, but were very sluggish. I collected some of these and carried them home, but they all died apparently from wilt," etc.

Mr. Houser enclosed some of the caterpillars he collected at that time. The abundance of the polyhedra in these caterpillars shows that they died of wilt.

Distribution—Group B

The insects contained in this group are reported on the authority of European investigators, who in the course of their studies of the disease of the Nun moth and silkworm caterpillars, either found a similar disease in these other species or by inoculation with the virus of diseased Nun or silkworms produced a similar condition in them.

Though details are generally lacking, enough information, in case of the majority of the caterpillars, is given to dispel any doubts one may have that the observers were not dealing with true polyhedral diseases. However, in regard to the production of the polyhedral-sickness in the larvæ of beetles and flies we do not feel so confident. Without going into too minute detail we should like to know whether the wilt ever occurs in these insects naturally. Also if all the typical symptoms are manifested in these individuals as in caterpillars. Until this and other more detailed information is forthcoming, we cannot come to any decision on the matter, further than to say all our own efforts in this direction have resulted negatively.

Distribution—Group C

We believe the species in this group should be reported at this time because they are all of more or less economic importance and particularly because they have a caterpillar malady which has checked them considerably, if not completely controlled them at some time or other. The various observers who have worked on the life histories and habits of these pests or have studied some special outbreak of them have made special mention of these maladies and their possible importance as factors in controlling these pests.

In looking over the histories of these diseases and in some instances getting the information at first hand from the investigators themselves, we were impressed with the similarity of many of them to wilt. With the exception of *Colias philodice*, we have not examined any diseased caterpillars of this group. A few Colias caterpillars which we tried to infect by feeding them army worm wilt died. They did not show the typical wilt symptoms. However, on examination a few polyhedra were found. We are inclined to believe that their presence in the Colias caterpillars was due to the unsatisfactory manner of feeding. Some of the material may have dried on the skin of the caterpillars. It was then washed off when the caterpillars were crushed for examination. Until this experiment is repeated several times or the wilt is found naturally in this species we cannot accept these results as final.

Comparative Study of Polyhedra

The question now arises whether or not there is more than one disease in the condition known as wilt. In Europe, as we have already pointed out, in a previous paper (Dec., 1913), there is a tendency to diagnose insect diseases, where polyhedra are present, as "Polyederkrankheit" or polyhedra-sickness. The idea is excellent, for though the diseases may not be identical they are similar in many respects[1] and until we know more about their cause certainly no harm can come from grouping them in this way.

We have adopted this scheme as will be seen from the preceding list of insects known to have polyhedra, and we have used wilt synonymously with "Polyederkrankheit."

Returning now to the question whether or not there is more than one disease concerned with wilt. We undertook a comparative study of the polyhedra in the different species of caterpillars: first, to see what light if any could be thrown on this phase of the problem; second, if by such a study we might determine the relation of the polyhedra to wilt.

We proceeded as follows: Smears were made either from fresh or dried wilt material. These were dried, fixed by passing through a flame, and stained by Giemsa's method. Five fields, of ten adjacent polyhedra each were drawn by camera lucida from each slide (one from each of the four corners and one from the center). These were drawn at the same magnification and at the height of the stage of the microscope. A stage micrometer was also projected and drawn. All measurements were then made with this enlarged scale. This projected scale was afterwards checked with measurements by an eyepiece micrometer.

We are not able at this time to present polyhedra from all the species named in group A. Unfortunately the few specimens of wilt of the Range caterpillar and army worm which we examined were not preserved. We can say however they differed in no material way from the polyhedra of the other eight species we have presented. (See Pl. 6, figs. 1–8).

As to the first part of the question. We must admit the comparative study of the polyhedra has added little of positive value; for with the exception of the silkworm caterpillars (Pl. 6, fig. 4, after Prowazek) which are distinctly rhomboidal, seldom pentagonal or hexagonal, there exists a striking similarity in shape between the polyhedra of the other seven species. If it is true that some of the polyhedra are more

[1] (1) Have polyhedra, (2) become flaccid, (3) hang by the prolegs, (4) body tissues become saponified, (5) and there is both a chronic and acute type in nature.

angular than others but with the possible exception of the tent caterpillars, this is characteristic of individual polyhedra in the same caterpillars, where they may vary from an almost spherical to a decidedly angular form.

Another striking fact is the great difference in size between the polyhedra in the different species studied. (Pl. 6, figs. 12–14.) Taking the average of five microscopic fields in each species studied, the polyhedra of the gipsy moth are the largest, measuring 3.4μ in diameter and those of the tussock moth the smallest, measuring 1.64μ in diameter. The polyhedra of the other species are intermediate in size. Glaser in his study of the polyhedra of the gipsy moth caterpillars found some measuring as much as 15μ in diameter, while in the same caterpillar there were many measuring 1.5μ and 2μ in diameter with all possible gradations between these two extremes.

As to the second part of the question, what relation have the polyhedra to wilt? We have previously stated (Dec., 1913) that the polyhedra were reaction products, a view also held by many European investigators. This view we further believe is strengthened by the present study of the polyhedra.

A further study was made of some polyhedra taken from caterpillars which died in experiments of cross infection. (Pl. 6, figs. 9–11.) That is, apple tent caterpillars were fed with gipsy moth wilt and gipsy moth caterpillars were fed with Nun wilt. A number of such infections were tried but the reciprocal infections were not made. Until this is done we cannot express a definite opinion on the results we have obtained so far. We present it more to call attention to or to show what might be done in the future in an experimental way, that might give the solution to the problem.

We wish at this time to thank all those who have in any way aided us in this work; especially those who have sent us material from the field.

Summary and Conclusions

1. Wilt occurs in many widely different species of insects.
2. The clinical aspects of wilt are very similar in all the species of caterpillars studied by us.
3. Wilt first appears in a chronic form, as conditions become more unfavorable it becomes acute, and finally terminates in a general epidemic.
4. There is a striking similarity in shape between the polyhedra of the different species of caterpillars given in Group A.
5. The polyhedra in the different species vary greatly in size.
6. The great difference in size which exists between polyhedra in the same caterpillar tends to strengthen our view that the polyhedra are reaction bodies.

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Explanation of Plate 6

Note.—Each figure consists of one microscopic field of ten adjacent polyhedra. Two measurements are given under each figure. The first refers to the average size of the ten polyhedra given in each figure. The second is the average of five such microscopic fields.

Fig. 1. Polyhedra of a Gipsy moth caterpillar.
(Average size 3.4μ and 3.39μ)

Fig. 2. Polyhedra of a Nun moth caterpillar.
(Average size 2.65μ and 2.43μ)

Fig. 3. Polyhedra of a Forest tent caterpillar.
(Average size 2.6μ and 2.5μ)

Fig. 4. Polyhedra of a silkworm.
(After Prowazek) Mag. 1400 diam.

Fig. 5. Polyhedra of an Apple tent caterpillar.
(Average size 2.05μ and 2.2μ)

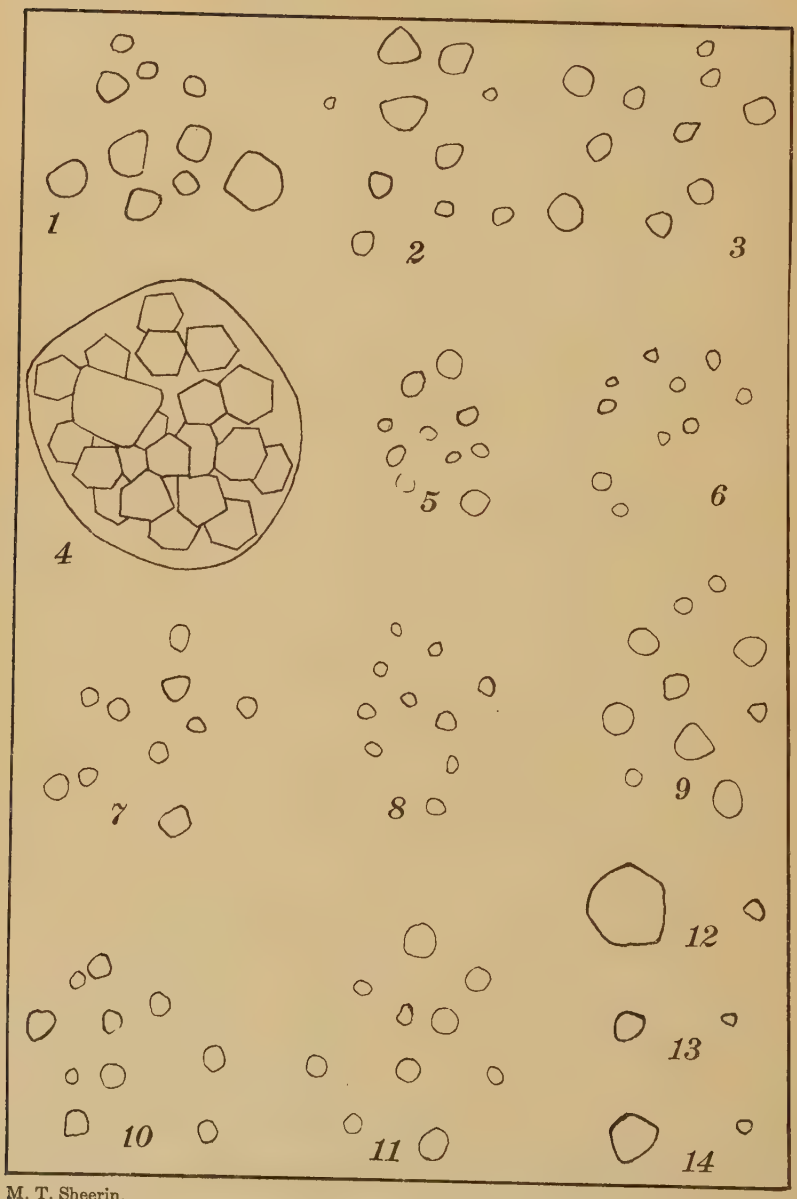
Fig. 6. Polyhedra of a Tussock moth caterpillar.
(Average size 1.5μ and 1.64μ)

Fig. 7. Polyhedra of an army worm.
(Average size 2.3μ and 1.88μ)

Fig. 8. Polyhedra of a Phryganidia caterpillar.
(Average size 1.6μ)

Fig. 9. Polyhedra of a Gipsy moth caterpillar fed Nun wilt.
(Average size 2.5μ and 2.1μ)
Fig. 10. Polyhedra of a Gipsy moth fed Phryganidia wilt.
(Average size 2.15μ and 2.1μ)
Fig. 11. Polyhedra of an Apple tent caterpillar fed Gipsy moth wilt.
(Average size 2.35μ and 2.2μ)
Fig. 12. Polyhedra of a Gipsy moth caterpillar.
(Showing two extremes)
Fig. 13. Polyhedra of an Apple tent caterpillar.
(Showing two extremes)
Fig. 14. Polyhedra of a Forest tent caterpillar.
(Showing two extremes)

Drawn by camera lucida. (Ocular 6, Oil immersion $\frac{1}{12}$, tube length 160 mm.)



M. T. Sheerin.

POLYHEDRA OF VARIOUS CATERPILLARS

THE LUMINOUS ORGAN OF THE NEW ZEALAND GLOW-WORM

By W. M. WHEELER and F. X. WILLIAMS

[Reprinted from Psyche, Vol. XXII, No. 2]

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THE LUMINOUS ORGAN OF THE NEW ZEALAND GLOW-WORM.[1]

By W. M. Wheeler and F. X. Williams.

The earliest description of the New Zealand glow-worm seems to be given in a brief note by Meyrick published in the *Entomologists' Monthly Magazine* for 1886. This observer found a number of larvæ, which he supposed to be those of a Staphylinid beetle, on the damp, precipitous banks of a densely shaded creek near Auckland. The larvæ were described as burrowing "in the earth, exposing the head and anterior portions from the burrow but having in front of them a sort of irregular slimy network." They occurred in such numbers that more than fifty were counted in a square foot of surface. Meyrick states that the same or a similar species has been noticed in caves and mines in other parts of New Zealand. He says that "the light consists of a small light-greenish white erect flame rising from the back of the neck," and that the food of the creature consists of minute insects probably attracted by its light.

During 1886 and 1887 Hudson published accounts of the insect and pointed out several errors in Meyrick's description. He showed that the luminous larva is not so numerous in a given area, that its light does not proceed from the neck but from a large glutinous knob at the posterior end of the body and that it inhabits irregular cavities in the earthen banks "where it hangs suspended in a glutinous web, which also appears to envelop the body, large quantities of sticky mucous being periodically shot out of the mouth of the larva and formed into threads as required." Hudson supposes that the larva feeds on decaying vegetable matter. He saw the light displayed most brilliantly at 3 or 4 o'clock in the morning but on several occasions observed no light all the evening. The light does not serve to attract food but "to assist the larvæ in escaping from enemies, as when disturbed they nearly always gleam very brilliantly for a few seconds, suddenly shutting off the light and retreating into the earth." The imago reared in the breeding cage proved to be a Tipulid fly which

[1] Contributions from the Entomological Laboratory, Bussey Institution, Harvard University, No. 86.

was identified as *Trimicra pillipes* by Baron Osten-Sacken. The noted dipterist, however, regarded the luminous larvæ sent to him as those of a Mycetophilid (1886).

A more exhaustive account of the life-history of the New Zealand glow-worm was published by Hudson in 1891. He studied the insect in the deep ravine of the botanical garden at Wellington and with some difficulty worked out its transformations. It proved to be a Mycetophilid and was described by Skuse as *Bolitophila luminosa* in an appendix to Hudson's paper. The imago, identified by Osten-Sacken as *Trimicra pallipes* did not, therefore, develop from one of the luminous larvæ but from another larva that had accidentally entered Hudson's breeding cage. The pupa of the *Bolitophila* is figured with a large branched and apparently tracheal process on the prothorax. The anal segment was found to be luminous in life and the imaginal flies, all of which proved to be females, were also luminous, emitting from the tip of the abdomen "a strong light about half as bright as that emitted by a full grown larva."

On September 5, 1914, the senior author, while visiting New Zealand, took part, through the kindness of Mr. T. F. Cheeseman, in an excursion to the Waitakari Forest, near Auckland, for the purpose of inspecting some of the few large surviving kaori-pines (*Agathis australis* Salisb.). In order to reach the forest by a short cut it was found convenient to traverse a dark tunnel many yards in length excavated through a small mountain and serving as a viaduct for a pipe from a large reservoir to the water-works of the city of Auckland. The walls of this tunnel were spangled with beautiful blue-green sparks, which proved, on examination, to be the luminous *Bolitophila* larvæ described by Hudson. They varied from about 1 to 3.5 cm. in length and were living on slender glutinous threads which, in some cases, depended from the ceiling of the tunnel. Several of them, transferred to a moist vial, were later examined under a strong pocket lens and showed the luminous organ very distinctly in the dilated ovoidal terminal segment of the body. This segment bears a pair of small, jointed cerci and is, therefore, probably the eleventh abdominal metamere. The organ appeared as four parallel rods closely applied to one another in the middle of the vesicle on the ventral surface of the very slender rectum. Their long axes were parallel with the long

axis of the body and all were slightly curved, so that the oblong plate which they formed together was concave on the dorsal and convex on the ventral surface. They gave off a bluish-green light most intensely from their dorsal surfaces, as their ventral surfaces appeared to be covered with a vague mass of reflecting tissue.

The specimens were killed in 50 per cent. and then transferred to 70 per cent. alcohol, which seemed to preserve them sufficiently well for subsequent study. The junior author sectioned a number of the specimens and stained them with Heidenhain's iron hæmatoxylin. He also obtained excellent views of the structures as whole mounts or partial dissections stained in alum cochineal.

Fig. 1, Pl. 3, represents one of the larvæ in lateral view. The head is very small, with minute eyes; the long body grows broader posteriorly and terminates in a bulbous enlargement or vesicle, separated by a distinctly constricted region from the more anterior segments. If this constricted region is counted as a segment the abdomen has the full number, eleven, of segments characteristic of insects. Hudson's figure of the larva (Pl. 8, Fig. 1) is certainly incorrect, since it represents no less than nineteen post-thoracic segments and the outline of the terminal bulbous segment is defective. It is probable that this region in our figure is too small, as it was drawn from a preserved and perhaps somewhat shrunken specimen.

The peculiar glutinous web on which the larva moves about is evidently secreted by a pair of voluminous spinning glands situated in the anterior two thirds of the body. Their posterior tips are represented at SG in Fig. 2, which is drawn from a dissection of the slender hind-gut and the accompanying Malpighian tubules in the posterior third of the body as seen from the ventral side. These Malpighian tubules are four in number as in other Diptera and all come off at the same level, run forward a short distance and then turn back with more or less convolution, applying themselves to the sides of the slender intestine. They gradually diminish in diameter till they become very tenuous and straight in the constricted region just anterior to the terminal vesicle and are there closely applied to one another side by side on the ventral surface of the rectum. Then they separate along the median line into two pairs and again come together but increase two and one-half to three times in diameter in the vesicle where they

terminate with rounded tips. It is these dilated tips of the four Malpighian tubules which appear as the four curved, luminous rods in the living larva and, therefore, constitute the photogenetic organ. What to all appearances serves as a reflector is represented by a layer of tissue (R, Figs. 3 and 7) of variable thickness, covering much and in life perhaps all the ventral surface of the dilated ends of the tubules. A pair of large tracheæ, shown at T, enters this layer and each breaks up almost immediately into three branches, one of which runs back between each of the two pairs of Malpighian tubules. The reflecting layer seems to be a syncytium made up of the hypertrophied and finely vacuolated tracheal epithelium, as it reveals no cell boundaries. It contains numerous small nuclei which are all at one level well within the mass (Fig. 7) and close to the chitinous tracheal intima. Anteriorly the reflecting layer extends for a short distance along the two main tracheal trunks, but posteriorly it thins out into a membrane which partly serves to secure the tubules to the rectum. Some slender longitudinal muscles, shown at M in Fig. 3, have the same function. It is probable that the reflecting syncytium may in life contain numerous fine vacuoles of a fatty substance which has been dissolved away in the mounted preparations. We do not believe that this layer is derived from the fat-body, because the latter, as shown in Fig. 5, consists of larger cells with definite boundaries and large, spherical nuclei.

It thus appears from dissection that the Malpighian tubules are each differentiated into two portions with very different functions, viz., a short distal piece which is photogenetic and a long proximal portion which retains the primitive excretory function of these organs. The portion anterior to the subterminal constriction of the body shows in both stained and unstained material a more opaque and vacuolated structure of its cells, with darker nuclei; the slender intermediate region (Fig. 2S) is much more transparent and its nuclei are paler, while the photogenetic portion is also rather pale but consists of much larger cells. In sections these structural differences are even more marked. No sections were taken near the points of origin of the Malpighian tubules, but it is evident from a specimen stained *in toto* that the lumen is here quite large. A section through the middle region is shown in the lower of the two drawings in Fig. 4. The wall of the tubule shows

only two cells, both so much swollen as to reduce the lumen to a mere line, except at one side where the wall is reduced to a mere membrane bounding a small passage. The canal may be even more reduced than in the section figured, but it is commonly slit-like and was never seen to be large and circular in this region. The cells are vacuolated and contain some darkly staining granules. A section through the intermediate narrow portion of the tubule just in front of the photogenetic region and corresponding with the point S in Fig. 2 is shown in the upper drawing of Fig. 4. The lumen, though similar to that in the anterior region, is more evident. The cell content is denser and more granular and approaches that of the cells in the luminous organ. All four tubules of this latter region are shown in cross-section in Fig. 7. They are circular, with large lumina, and the walls consist of four well-defined cells, with large spherical nuclei. Their cytoplasm is throughout densely packed with minute granules which stain very deeply, so that the tubules stand out in marked contrast with the underlying reflecting layer. Evidently these granules correspond in function with the photogenetic granules in the luminous organ of the fire-fly. Vacuoles are rare or altogether lacking in these cells, as in the section figured. The lumina of the tubules often enclose a granular deposit which may represent the stained residue of a liquid contained in them during life. The extreme tips of the Malpighian tubules, shown in section in Fig. 6, recall the structure of the anterior excretory portion, since the large granular cell-wall here thins out dorsally to a delicate membrane which closes the end of each of the tubules.

Although the luminous organ of the pupal and imaginal *Bolitophila* has not been studied we may safely assume that it is the same as that of the larva. This is clearly indicated by Hudson's statement that in both the larval and pupal instars it is the last abdominal segment which is luminous, and the fact that at least in Nematoceran Diptera, if we accept the studies of Vaney (1902) on *Simulium* and *Chironomus*, the larval Malpighian tubules are not broken down during metamorphosis but persist with their structure essentially unaltered in the pupa and imago.

The conversion of the distal portion of each of the four Malpighian tubules into a luminous organ in *Bolitophila* is of considerable interest both morphologically and physiologically; morpho-

logically because a single, definite organ is formed by the union or "allelotaxis" of parts of four discrete structures in a manner somewhat analogous to that of the formation of the pituitary body of the Mammalian embryo, and physiologically, because in no other insect are the Malpighian tubules known to have a photogenetic function. Still the assumption of this unusual function does not at present come as a very great surprise, because, though the Malpighian tubules seem to be purely excretory in the great majority of insects, several cases have recently come to light of their acquisition of another function. Thus it has been shown that in larvæ belonging to widely different orders, such as *Chrysopa*, *Myrmeleon* and *Sisyra* among the Neuroptera, and *Lebia* and probably also *Phytonomus* and other Rhynchophora among the Coleoptera, portions of the Malpighian tubules have taken on a secretory function and produce the silk from which the cocoon is spun. The Malpighian tubules of insects are, therefore, functionally more plastic organs than we had supposed and present in this respect a certain analogy to the fat-body, which commonly combines the functions of hæmatopoësis, and the storing of fatty and albuminoid substances and urates. Less frequently, however, the fat-body shows a development of certain of its parts into photogenetic organs (Lampyridæ) and into isolated cells (mycetocytes of Blattidæ) or organ-like cell-aggregates (mycetomata of many Homoptera), which serve as the habitacula of symbiotic Bacteria and Saccharomycetes.

The only other luminous Mycetophilid to which we have been able to find a reference in the literature is *Ceroplatus sesioides*, described many years ago by Wahlberg (1849) from Sweden. The larvæ of this insect live gregariously beneath a glutinous web on the under surfaces of mushrooms (*Polyporus fomentarius*). Wahlberg found the whole body to be luminous in the larval and pupal but not in the imaginal stage. His brief account would seem to indicate that photogenesis in this species, as in certain Chironomidæ, may be due to the presence of phosphorescent Bacteria.

We have endeavored to discover the nature of the food of the larval *Bolitophila luminosa* from examination of the contents of the alimentary tract both in dissections and sections and have found that the creature undoubtedly subsists on insects. The intestine in all the specimens examined was loosely filled with

small pieces of chitin, often covered with hairs. Some of the pieces belonged to small gnats allied to the Chironomidæ. In one case a mandible of some small insect larva was found among the fragments. No traces of vegetable matter could be detected. As the head and mouthparts of the larva are extremely small it seems very unlikely that it can seize and dismember active, living prey. It is much more probable that small flying or creeping insects are caught and killed or disabled in the glutinous web and then leisurely devoured by the larva when it comes upon them in its wanderings along the threads. Hudson rejects this supposition on what appears to us to be rather feeble negative evidence. The nature and arrangement of the web certainly indicate that it is used as a trap. He describes it as follows in his second paper (1891): "The web referred to above is suspended in a rocky or earthy niche in the banks of streams in the densest parts of the forest. It consists of a thick glutinous thread stretched across the niche, and supported by several smaller threads running right and left, and attached to the sides and end of the cavity. On this the larva invariably rests, but when disturbed immediately glides back along the main thread, and retreats into a hole which he has provided at the end of it. From the lower side of this central thread numerous smaller threads hang down, and are always covered with little globules of water, resembling a number of minute silver-beaded necklaces, constituting a conspicuous, though apparently unimportant, portion of the insect's web."

That the web must serve as a trap is suggested also by O. F. Cook's recent description (1913) of a similar though more elaborate structure spun by what is in all probability a Mycetophilid larva in the caves of Alta Verapaz, Guatemala. In this case the glutinous web is figured and described as resembling "the rope signals that are hung near bridges and railroad tunnels to avoid accidents to train-crews." Cook found embedded in the slimy threads several small insects such as mosquitoes and other soft-bodied species and even a small beetle, and believes that these constitute the food of the larva.

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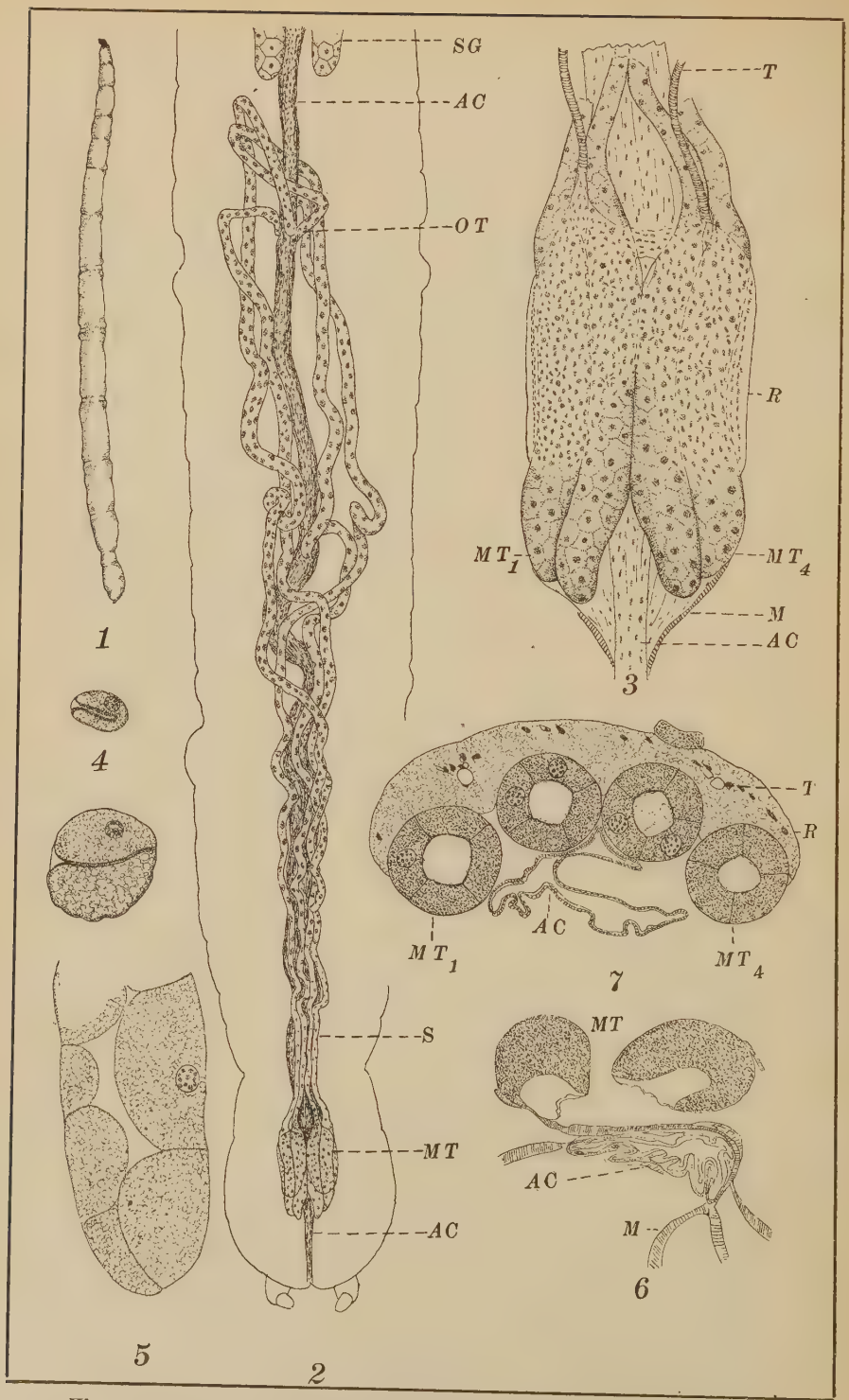

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1886. *Osten-Sacken, C. R.* A Luminous Insect-Larva in New Zealand. Entomologist's Month. Mag. 1886, pp. 133, 134

EXPLANATION OF PLATE 3.

Abbreviations used: AC, alimentary canal; M, muscle; MT, MT_1, MT_4, portions of Malpighian tubules forming photogenetic organ; OT, point of origin of Malpighian tubules; R, reflector; S, slender, intermediate region of Malphigian tubule; SG, salivary gland; T, trachea.

Fig. 1. Full-grown larva of *Bolitophila luminosa*, from an alcoholic specimen; lateral view.

Fig. 2. Caudal third of body of larva, showing alimentary canal and Malpighian tubules; ventral view.

Fig. 3. Distal portion of Malpighian tubules modified to form photogenetic organ; ventral view.

Fig. 4. Cross-sections through Malpighian tubules; the smaller, upper section from the region S, Fig. 2, the larger, lower one from a region much further forward.

Fig. 5. Section of a piece of the fat-body from the last abdominal segment.

Fig. 6. Cross-section through tips of photogenetic portions of two of the Malpighian tubules.

Fig. 7. Cross-section through the middle of all four of the Malpighian tubules in the photogenetic region. The reflecting layer R is ventral.

On the External Anatomy of Adelphocoris rapidus Say, with Reference to the Taxonomy of the Miridae or Capsidae (Hemip.).[1]

By H. M. Parshley, Bussey Institution, Harvard University.

(Plate VII.)

During the preparation of this brief discussion of Mirid anatomy, I had occasion to consult the writings of various students of the Hemiptera, and I am, in consequence, able to present evidence which seems to settle definitely the much disputed question regarding the correct name for the family under consideration. Kirkaldy in 1902 adopted the name Miridæ in place of the universally used Capsidæ in accordance with the principle that the family name should be derived from that of the oldest included genus.[2] Others, however, believe that the rule of priority should obtain in determining the family designation, the first name in Latin form thus being the one which should be accepted. Among those who hold this view is Horvath, who in 1911 published a paper[3] in which he attempted to fix the proper names for the several families of Hemiptera. This article[4] furnishes information of value, but some of the names adopted are not consistent with the main principle of the paper. As it happens, it is not necessary to look into the respective merits of these two views in deciding upon the correct name for the family. *Miris* is certainly the oldest genus in the family, and should be the basis for the family name if the oldest genus is to be regarded as the type. On the other hand, the oldest name to be given to the family was *Mirides*,[5] proposed by Hahn[6] in 1831. This term was used in a systematic table in a book with German text, and it is therefore a true Latin form, of which *Miriden* would be the vernacular equivalent.

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 87.

[2] *Miris* Fab., 1794; *Capsus* Fab., 1803.

[3] Ann. Mus. Nat. Hung., ix, 1911, p. 1.

[4] Reviewed by Van Duzee, Ent. News, xxii, 1911, p. 431.

[5] Overlooked by Horváth, l. c.

[6] Wanz. Ins., i, 1831, p. 234.

Thus it is by no means a vulgar name as suggested by Van Duzee.[7] To conform with modern usage the termination must be changed to *-idae,* but this cannot affect the nomenclatorial standing of the term. Similarly subfamily and tribal names must now end in *-inae* and *-ini* respectively, but no one thinks of ignoring the subfamilies and tribes of Stål and Reuter because these authors used the terminations *-ina* and *-aria* in naming those groups.[8] Reuter, Bergroth, and others[9] have adopted the name Miridae, and we may well follow them since their view seems to be supported by the evidence, from whichever standpoint it may be viewed.

As a basis for this review of the external characters of the Miridae, I have used a common and widely distributed species, introducing such comparative material as I have found available. Most of the technical terms will be found equally applicable in the other families of Heteroptera. Earlier treatments of the subject may be found in the writings of the authors cited, especially in the works of Reuter,[10] which are fundamental for the study of this family.

The Head. (Plate vii, fig. 1.)

The term **tylus** (*clypeus*) may well be applied, as in other families of Heteroptera, to the anterior median portion of the head.[11] The triangular pieces on each side of the tylus may for the same reason be called the **juga** (the *Jochstücke* of Reuter). The **lorae** (*Kopfzügel, maxillary laminae*[12]) lie just inferior to the juga, from which they are set off by an impressed line. Below and posteriorly they may be fused with the genae (*lorae confluent*), as in fig. 1; or they may be marked off by a fine line (*lorae discrete*), as in fig. 9. The **genae** (*Wangen*) are largely occupied above by the eyes. Be-

[7] Can. Ent., xlvi, 1914, p. 386.

[8] A parallel case in the nomenclature of the Formicidae has been brought to my attention by Dr. W. M. Wheeler.

[9] Van Duzee (*in litt.*) now accepts this view.

[10] See especially Acta Soc. Sci. Fenn., xxxvii, No. 3, 1910, p. 84 (Phyl. u. Syst. Mir.)

[11] For a discussion of the true morphological nature of these parts see Muir and Kershaw, Psyche, xviii, 1911, p. 1.

[12] See Tower, Ann. Ent. Soc. Am., vi, 1913, p. 427. Anatomy of the Squash Bug.

low the eyes their vertical width is generally slight, as in fig. 1 (*genae low*), but sometimes (*e. g.* in certain Restheniini), their width is great and may be equal to the vertical diameter of the eyes, as in fig. 9 (*genae high.*). The **bucculae** (*Wangenplatten*) are thin ridge-like plates partially enclosing the base of the four-segmented **rostrum** or beak. The **gula** (*Kehle*) is the posterior median part of the head below. As this part varies greatly in extent and position in different species, it furnishes valuable taxonomic characters. In the Miridae the **antennae**, fig. 8, always consist of four segments, but otherwise, by their great diversity in form, vestiture, and proportions, they present important and easily observable criteria.

The Prothorax.

The anterior margin of the prothorax in certain groups is provided with an **apical stricture**, a complete collar-like annulus set off by an impressed line, figs. 1, 7, 9. In other groups, for instance in the tribe Mirini, the apical stricture is lacking, although sometimes a false and incomplete stricture is formed by the anterior margins of the calli and the humeral impressed lines, as in *Miris*, fig. 6. The **coxal cleft**, fig. 1, also produces at times the impression of a stricture when viewed laterally. In all cases the presence or absence of a true apical stricture should be carefully noted, as this character is of major importance in classification. The **calli** are two more or less raised areas situated anteriorly on the pronotum, figs. 6, 7. The prosternal **xyphus** is a part of the prosternum appearing as a triangular plate between the anterior coxae. In *Adelphocoris* it is limited in front by the apical stricture and is concave with raised margins, while in other groups it may be convex or even conical and without raised margins, thus affording important taxonomic characters.

The Mesothorax. (Plate vii, fig. 1.)

The pleural region is very clearly divided by an oblique line into two parts, furnishing one of the distinctive characters of the Miridae, these structures, when present, being much less clearly defined in other families. The larger and antero-in-

ferior part is the **episternum**, the smaller and postero-superior the **epimeron.**[13] The dividing line is not a true suture, but results from an infolding of the integument for muscle-attachment. It appears significant that the high development of these structures is correlated with the characteristic activity of these insects, which run about with great rapidity and take wing almost as readily as flies. In the Miridae and certain closely related families the **sternum** is composite, the parts being separated by a median longitudinal suture and confluent on the sides with the episterna.

The Metathorax. (Plate vii, fig. 1.)

The pleural region is divided as in the preceding segment but here the epimeron is relatively smaller. The **orifices** of the scent glands lie between the middle and hind coxae. They are of very variable form in this family and may be reduced or absent in certain groups. The sternum is composite.

The Abdomen.

The abdomen in the Miridae consists of ten segments, all of which can be seen only in a dorsal view. The **spiracles**, fig. 1, are located laterally, near the dorsal edge of the ventral segments, except the first pair which is on the tergum. The **genital segments** are very different in the sexes, figs. 1, 2, 3, the male being asymmetrical. Good specific characters will doubtless be afforded by the genitalia, but these structures are yet to be investigated in detail.

The Arolia.

The parts of the legs, fig. 8, afford a number of characters, all of which are easily observable, except the **arolia**, which require some discussion, being very important taxonomically though somewhat obscure. In *Adelphocoris*, fig. 10, the arolia are to be seen as two elongated membranous structures attached to the end of the last tarsal joint between the claws. They are approximated basally and divergent apically. In *Lopidea*,

[13] This use of these terms corresponds with that common in other orders but hardly agrees with Reuter's statement (l. c. p. 90), where some error, possibly typographical, seems evident.

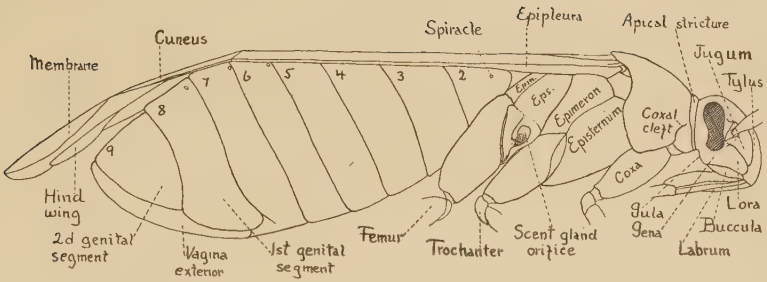

Fig.1. Lateral view of Adelphocoris rapidus ♀.

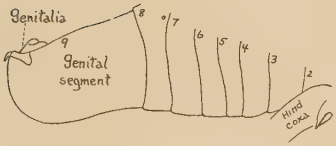

Fig.2. Abdomen of A.rapidus ♂, right side

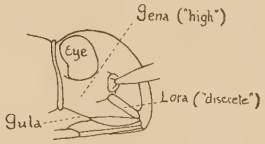

Fig.9. Diagram of head.

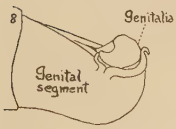

Fig.3. A.rapidus ♂, left side

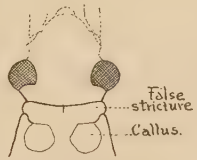

Fig.6 Miris dolobratus.

fig.10. A.rapidus

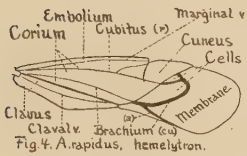

Fig.4. A.rapidus, hemelytron.

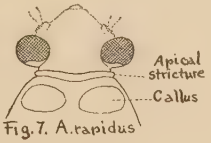

Fig.7. A.rapidus

Fig.11. Monalocoris filicis

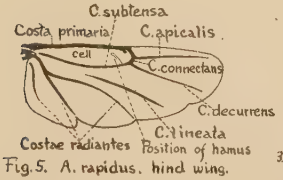

Fig.5. A. rapidus. hind wing.

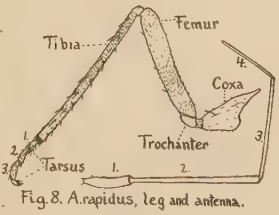

Fig.8. A.rapidus, leg and antenna.

Fig.12. Lopidea media

fig. 12, they are distant basally and convergent apically. In *Monalocoris,* fig. 11, they are distant basally, but diverge widely so that they remain close to the claws throughout their length. In the subfamily Bryocorinae, to which this genus belongs, the arolia are sometimes adherent to the claws for the greater part of their length, and in certain groups they may be entirely absent. These facts may be generalized, giving the following types of arolia:

1. Divergent, approximated at base, fig. 10.
2. Divergent, distant at base, fig. 11.
3. Convergent or parallel, distant at base, fig. 12.

The Wings.

The **hemelytron**, fig. 4, consists of the **clavus, corium, embolim,**[14] **cuneus** and **membrane,** the distinctness of which parts constitutes one of the characters of the family Miridae.[15] The veins of the hemelytra, according to the opinion of Bergroth,[16] should be named morphologically as indicated in parentheses in fig. 4. However, there is some doubt in my mind whether or not this application of the Comstock-Needham terminology is wholly correct, and comparative studies in the Heteroptera are needed to establish fully the homologies involved. Purely systematic terms are not available for all the veins, as only two have received names. Thomson[17] called the outer vein of the corium **cubitus** and the inner **brachium,** and Reuter employs these names because of established usage, though he questions the correctness of the term cubitus.[18] According to the latter author, the brachium, on emerging into the membrane, forms the outer boundaries of the two **cells,** the dividing line between the cells being an extension of the cubitus. The vein of the clavus may be called the **claval** and that near the anterior margin of the wing the **marginal.** The inner longitudinal vein of the membrane has not been used

[14] Not distinct in *Adelphocoris,* but clearly marked off in other groups, *e. g. Hyaliodes* Reut.
[15] And Anthocoridae.
[16] Ann. Soc. Ent. Belg., lvi, 1912, p. 148, footnote.
[17] Opuscula Entomologica, fasc. iv, 1871, p. 411.
[18] Festschrift f. Palmén, No. 1, 1905, Hem. Spec. I, p. 31.

taxonomically, and, in fact, appears to have been overlooked by Reuter and previous authors as noted by Bergroth (l. c.), who calls it an **anal** vein. Sometimes the membrane is one-celled, and in certain Restheniini several longitudinal veins may be present.

The veins of the metathoracic wing were named by Fieber[19] as shown in fig. 5. Reuter uses the same names, substituting the word *"vena"* for **costa** in each case. In certain groups a short and incomplete vein, the **hamus**, projects backward into the cell from the costa subtensa. This structure is considered by Reuter to be of importance in tracing phylogenetic relationships, its presence indicating a relatively primitive condition. It is absent in *Adelphocoris,* which belongs to the Capsini, a highly specialized tribe of the subfamily Mirinae, but in the figure I have indicated its position as it occurs in *Plagiognathus,* which belongs to the Phylinae, a more primitive group.

Conclusion.

The main anatomical features on which is based the classification of the Miridae may be summarized as follows: The form and structure of the arolia; the presence or absence of the apical stricture of the pronotum; the structure of the lorae; the presence or absence of a wing-hamus; the venation of the membrane, and the extent of the genae. Among the many other characters of lesser import, used in defining the lower groups, may be mentioned the structure of the xyphus; the form and proportions of the antennal segments; the shape of the head, prothorax, and parts of the hemelytra; and the position of the hind coxae. These characters were discovered by various authors, but the determination of their relative importance and their employment in a coherent and comprehensive system are in great measure the work of Reuter. Color and markings are for the most part very variable within specific limits, and this, together with the fact that certain structures also exhibit intra-specific variability, indicates that there is in this family an opportunity for work on incipient species and varieties which will be of general biological interest.

[19] Eu. Hem. 1861, p. 13.

Some Additions to the North American Ant-Fauna.

By William Morton Wheeler, Ph.D.

BULLETIN OF THE

AMERICAN MUSEUM OF NATURAL HISTORY,

Vol. XXXIV, Art. XII, pp. 389–421.

New York, June 4, 1915.

(*Continued from 3d page of cover.*)

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59.57,96(7)

Article XII.— SOME ADDITIONS TO THE NORTH AMERICAN ANT-FAUNA.[1]

By William Morton Wheeler, Ph.D.

Family FORMICIDAE.

Subfamily Ponerinæ.

1. **Stigmatomma pallipes arizonense** subsp. nov.

Worker. Length nearly 4 mm.

Differing from the worker of the typical form in its somewhat smaller size, in having the head narrower in front so that the sides are nearly parallel, in the feebler development of the teeth at the anterior corners of the head and in sculpture, pubescence and coloration. The punctuation of the head and thorax is finer and denser so that these parts are distinctly more opaque than in the typical form, the pubescence is shorter and seems to be lacking on the upper surface of the head, and the whole body is dull ferruginous, with scarcely paler legs, whereas in the typical *pallipes* the head, thorax and petiole are usually blackish in mature specimens and the legs, mandibles and antennæ are testaceous.

Described from a single worker taken by Mr. W. M. Mann in Ramsay Cañon, Huachuca Mountains, Arizona, at an altitude of 5800 ft.

2. **Stigmatomma pallipes oregonense** subsp. nov.

Worker. Slightly larger than the typical *pallipes;* head somewhat shorter; antennal scapes longer, so that their reflected tips reach the lateral margin of the head two-thirds the distance from the anterior to the posterior corners; eyes distinctly larger; teeth on the anterior border of the clypeus smaller and more numerous (9 to 10). Petiole from above as broad as long, with convex sides. In the typical form it is distinctly longer than broad, with rather straight, subparallel sides. Sculpture, pilosity and color as in the type.

Female (deälated). Closely resembling the worker; eyes much larger than in the typical *pallipes.*

Described from eight workers taken at Marion, Oregon, by Rev. P. J. Schmitt O. S. B., and four females and five workers taken by Mr. Trevor Kincaid at Olympia, Washington.

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 88.

3. **Proceratium silaceum rugulosum** subsp. nov.

Worker. Body more heavily rugulose and therefore more opaque than in the typical form and darker and more brownish in color.

Female. (deälated.) Closely resembling the worker and differing from the female of the typical form in the same particulars.

Described from a single female and four workers taken by Mr. Wm. Blatchley at Wyandotte, Indiana. The specimens have been compared with four cotypes of *silaceum* collected by Rev. P. J. Schmitt at Beatty, Pennsylvania.

4. **Ectatomma** (**Parectatomma**) **hartmani** sp. nov.

Worker. Length nearly 3 mm.

Head distinctly longer than broad, subrectangular, with rounded posterior corners, convex above, a little broader behind than in front, with rather straight sides and feebly excavated posterior margin. Eyes a little behind the middle of the sides of the head. Clypeus short, rather convex, with its anterior border straight and entire in the middle. Mandibles rather long, distinctly triangular, the apical margin longer than the basal, not denticulate, meeting the basal margin at an obtuse angle which is neither membranous nor translucent. Antennæ moderately robust; scapes reaching nearly to the posterior corners of the head; first funicular joint as long as the two succeeding joints together; second joint as long as broad; remaining joints, except the last, broader than long. Thorax above feebly convex, slightly transversely impressed between the pro- and mesonotum, but without a suture; base and declivity of epinotum subequal, the latter concave and sloping, on each side above with a small protuberance but neither dentate nor tuberculate. Petiole shorter than high, convex and rounded dorsally, a little broader than long, its ventral surface with a blunt, compressed projection directed downward and forward. First gastric segment narrower and a little longer than the second, with a small, truncated tubercle on its anteroventral surface. Legs rather long; hind coxæ spined.

Somewhat shining, especially the mandibles, which are covered with shallow foveolæ and striated at the base. Clypeus, frontal area, head, thorax, including the epinotal declivity, and the gaster rather finely and regularly, longitudinally rugose. Antennal scapes and legs with minute, scattered, piligerous punctures.

Hairs white, erect, coarse, long and abundant, covering the body, legs and antennal scapes; funiculi with shorter, suberect hairs.

Body, mandibles and antennæ ferruginous red; legs somewhat paler and more yellowish.

Described from a single specimen taken by Mr. Carl Hartman at Huntsville, Texas. This is the first species of *Ectatomma* to be taken within the boundaries of the United States. Though similar in color and structure to the three known species of the subgenus *Parectatomma* (*rastratum* Mayr

of Brazil and Costa Rica, *triangulare* Mayr of Uruguay and Argentina, and *trigona* Emery of Brazil) it is much smaller. In the structure of the mandibles it is intermediate between these species and those of the subgenus *Guamptogenys* Mayr.

5. **Odontomachus hæmatoda coninodis** subsp. nov.

Worker. Length 6–8 mm.

Related to the subsp. *clarus* Roger, but the head is narrower and the body averaging smaller. The petiolar node is conical and convex behind and not acuminate at the tip or produced into a spine as in the typical *hæmatoda* and the subsp. *insularis* Guérin. The head, thorax, petiole and appendages are even paler and more yellowish than in *clarus* and the gaster is brown or dark red, with pale tip and segmental margins. The sculpture of the head and thorax is finer than in *clarus* and the surface a little more shining.

Female. Length 8–9 mm.

Resembling the worker and having the petiole of the same shape, but the sculpture and color of the female *clarus*, the gaster being blackish and the remainder of the body more reddish than in the worker. Wings grayish hyaline, with yellowish veins and stigma.

Described from one deälated female and seventeen workers taken Nov. 12–14 by myself in Hunter and Miller Cañons, Huachuca Mts., Arizona, at altitudes varying from 5000–7000 ft., and a single winged female taken during August by Mr. W. M. Mann in Ramsay Cañon, in the same mountain range. This subspecies, which forms small colonies and nests under stones, may be regarded as a depauperate desert mountain form derived from the subspecies *clarus*.

6. **Odontomachus hæmatoda desertorum** subsp. nov.

Worker. Length 9–10 mm.

Larger and more robust than the subsp. *clarus*, the head and thorax more coarsely sculptured and decidedly more opaque, the whole body, except the gaster, of a deeper, richer red, the mandibles, antennæ and legs scarcely paler, the gaster black, shining. The petiole differs in shape from that of the preceding subspecies and from *clarus* in having a rather long, gradually tapering and backwardly directed point. In profile both the anterior and posterior surfaces of the node, except very near its tip, are feebly convex. Pilosity and pubescence as in *clarus*.

Described from nine workers taken in the dry arroyo back of the Carnegie Desert Laboratory, near Tucson, Arizona. They were running over the dry soil. I did not succeed in finding the nest.

Subfamily DORYLINÆ.

7. **Eciton (Acamatus) leonardi** sp. nov.

Worker. Length 2–3 mm.

Head distinctly longer than broad, slightly broader in front than behind, with feebly convex sides and feebly excised posterior border. Eyes absent. Mandibles with 4 teeth, a prominent one at the tip and one at the base of the apical border and two smaller ones near the tip and separated by a concave diastema from the basal tooth. Antennal scapes slender at the base, but rapidly enlarging towards their tips, less than half as long as the head; funiculus not enlarged distally, joints 2–6 slightly broader than long, remaining joints at least as long as broad. Thorax less than $\frac{2}{3}$ as broad and about as long as the head including the mandibles, slightly broader anteriorly, with distinct mesoëpinotal and, in the large worker, very feebly indicated promesonotal suture, and slightly constricted at the former. Pronotum without a transverse anterior carina, about twice as long as the epinotum, in profile feebly rounded dorsally and a little higher than the epinotum; base and declivity of the latter subequal, the base with a somewhat triangular impression in the middle line at its anterior border. Petiole from above rectangular, about $\frac{1}{4}$ longer than broad, with straight, subparallel sides, in profile convex and evenly rounded above, its ventral surface slightly concave and with a small blunt tooth anteriorly. Postpetiole broader than long, distinctly broader than the petiole, a little broader behind than in front, with straight anterior and posterior borders and rounded sides. In profile this segment appears much shorter than high and has a distinct tooth at its antero-ventral border. Gaster oval, pointed, somewhat larger than the head. Legs rather short and slender; tarsi with simple claws.

Shining: mandibles rather coarsely striatopunctate; head and prothorax covered with sparse, rather coarse, piligerous punctures; on the remainder of the body these punctures are finer and much less conspicuous. Impression at base of epinotum slightly opaque and transversely shagreened.

Hairs pale yellow, only moderately long and abundant, erect or suberect on the body, legs and scapes; shorter on the funiculi; pubescence very sparse but rather long, visible on the gaster and posterior portion of the head.

Reddish yellow; clypeal region and mandibles red, the teeth of the latter black.

Described from three workers taken by Mr. Percy Leonard on Point Loma near San Diego, California. This species belongs to the group of small Ecitons including *E. californicum* Mayr, *nitens* Mayr, *commutatum* Emery, *pauxillum* Wheeler and *angustinode* Emery. From *pauxillum* it is readily distinguished by its greater size, the shape of the head, mandibles and pedicel; from *angustinode* by the greater size, much broader pedicel, more slender antennæ, shining epinotum, etc.; from *californicum* by the shape of the head, mandibles and pedicel, shorter thorax and different sculpture; from *nitens* by its smaller size and the absence of a pronotal carina, the shape of the mandibles, etc.; from *commutatum* by the shape of the mandibles, more slender antennæ and much feebler mesoëpinotal suture.

Subfamily MYRMICINÆ.

8. **Cardiocondyla emeryi** *Forel.*

A single worker of this species, which has not before been recorded from the United States, was sent me by the American Museum of Natural History from Miami, Florida. The species is widely distributed in the West Indies (St. Thomas, St. Vincent, Bahamas, Cuba, Porto Rico, Jamaica) and in several localities in the Old World tropics (Palestine, India, Madagascar, Polynesia).

9. **Solenopsis picta** Emery var. **moerens** var. nov.

Worker. Differing from the type of the species from Florida only in color, the whole body being uniform piceous brown, the mandibles, antennæ and legs brownish yellow.

Six workers taken by Mr. J. D. Mitchell from a dead pecan twig at Victoria, Texas.

10. **Solenopsis huachucana** sp. nov.

Worker. Length 1.5–2 mm.

Head subrectangular, distinctly longer than broad, a little broader in front than behind, with rounded posterior corners and nearly straight posterior and lateral borders. Eyes large, convex, with 6–8 facets in their greatest longitudinal diameter. Clypeus prominent, with strong median carinæ terminating at the anterior margin in two large, acute teeth; lateral teeth small and blunt, indistinct in some specimens. Mandibles with oblique 4-toothed apical margins. Antennæ slender, scapes reaching $\frac{2}{3}$ the distance from the eyes to the posterior corners of the head, club not longer than the remainder of the funiculus, but much broader, its basal fully half as long as its terminal joint; first and second joints much longer than broad, joints 3–8 fully as long as broad, at least in large individuals. Thorax through the pronotum a little more than half as broad as the head; in profile the dorsal outline of the pronotum is convex in front and straight and sloping behind to the short but pronounced mesoëpinotal constriction; epinotum with the base longer than the declivity, the former convex in profile, the latter sloping and concave, the angle between the two surfaces obtuse and much rounded. Petiole with a very short, narrow peduncle, the node slightly broader than long; postpetiole slightly lower and broader, nearly spherical above, a little broader than long; neither petiole nor postpetiole with a distinct tooth on the ventral side. Gaster elliptical, its anterior border concave in the middle.

Smooth and shining throughout, with very sparse and indistinct piligerous punctures on the body and legs.

Hairs whitish, bristly, of unequal length, erect on the body and moderately abundant, shorter on the antennal scapes and legs.

Yellow; posterodorsal portion of head and posterior half of gaster infuscated; some specimens also with the thorax slightly fuscous. Mandibular teeth black.

Female (deälated). Length 5.5 mm.

Head as long as broad, subrectangular, with rather convex sides and feebly excised posterior border. Eyes convex, nearly $\frac{2}{5}$ as long as the sides of the head. Antennal scapes not reaching half way between the posterior border of the eyes and the corners of the head. Mandibles with only 3 teeth. Lateral clypeal teeth obsolete. Thorax elongate elliptical, nearly three times as long as broad; epinotum rounded and sloping, without distinct base and declivity. Petiole not distinctly pedunculate, node high, compressed anteroposteriorly, its anterior slope concave in profile and rapidly rising to the rather acute summit, the posterior slope straight and abrupt. Postpetiole short, transversely elliptical, but little broader than the petiole.

Surface shining and very sparsely and minutely punctate as in the worker; erect hairs more abundant and more yellowish. Color of body rich yellowish testaceous, with a broad band across the posterior portion of the first gastric segment and the basal portions of the succeeding segments dark brown; mandibles and clypeus red.

Described from two females and numerous workers taken from two nests under stones in Miller Cañon, Huachuca Mts., Arizona, at an altitude of about 5500 ft. This species is readily distinguished in the worker phase from all the described forms of *Solenopsis* from the United States, except those of the *geminata* group, by its much larger eyes. There is a slight but distinct tendency to polymorphism in the worker adumbrating the condition seen in *geminata* Fabr. and *wasmanni* Emery.

11. **Solenopsis aurea amblychila** subsp. nov.

Worker. Differing from the typical *aurea* Wheeler in having the two carinæ terminating bluntly behind or at the anterior border of the clypeus and not projecting beyond the border as two acute teeth, in having the funicular joints 2–7 distinctly longer and in the mesoëpinotal suture, which, though as deeply impressed as in *aurea*, is more acute, i. e., not so broad at the bottom. The profile outline of the thorax is therefore different, the base of the epinotum and the posterior surface of the epinotum being more nearly straight in *aurea* and more rounded in the new subspecies.

Female. Differs from that of *aurea* in the same clypeal characters as the worker.

Male. Indistinguishable by any satisfactory characters from the male of *aurea*.

Described from many specimens taken from populous colonies nesting under large stones in the Huachuca Mts., Arizona (Ramsay Cañon 4800 ft.; Hunter's Cañon 5500 ft.; Carr Cañon 6000 ft.; Miller Cañon 5000–5400 ft.). I have also received a series of workers, males and females, from Guadalajara, Mexico, taken by Mr. J. F. McClendon.

12. **Solenopsis geminata sævissima** *F. Smith.*

In a recent revision of the *Solenopsis* species of the *geminata* group, Forel has made the important discovery that one of the forms generally attributed to this species lacks the large soldier phase, so that the worker caste is much less polymorphic. This form he originally described as the subsp. *pylades* from a female taken in Mexico, and to it he later referred workers from Colombia, Amazonas, Parà, São Paolo, Argentina, etc. I have recently revised the large amount of *geminata* material in my collection, and, although I am able to recognize most of the forms cited by Forel, I find myself unable to accept his interpretation and the name *pylades*. Forel is undoubtedly right in regarding this as a distinct form, but it is equally certain that it had been previously described by Fred. Smith under the name *sævissima*. In the first place, Smith's description is unusually good and applies perfectly to the typical yellow *pylades*. In the second place, his specimens were received from Bates, who gives an interesting account of the habits of this "fire ant" in Brazil. Moreover, Mr. W. M. Mann, who collected extensively in the region where Bates secured his specimens and made his observations, tells me that it is there the only common and widely distributed *Solenopsis*, and the numerous specimens collected by Mr. Mann prove to be typical *pylades* Forel. I believe I am justified, therefore, in resuscitating Smith's *sævissima* and in relegating *pylades* to the synonymy, but owing to the existence in the United States of the two following forms, which are clearly intermediate between *sævissima* and *geminata*, I am unable to regard the former as anything more than a subspecies of the latter.

13. **Solenopsis geminata xyloni** *MacCook.*

This form is widely distributed in Texas and is probably the same as the ant described by Buckley as *Myrmica sabeana*. The worker measures 2–5.5 mm. in length. The largest specimens are shaped like moderately large *geminata* workers, with rectangular head and the tips of the antennal scapes reaching on the sides of the head half way between the eyes and the posterior corners, but the surface of the head is much smoother and the scattered punctures much smaller, though larger and more conspicuous than in *sævissima*. The mandibles are not abruptly curved as in the largest workers of the true *geminata*. The color is variable, being in some of the largest workers deep red, with the posterior half of the gaster black, in others

the body is blackish red, with the mandibles and the anterior half or two thirds of the head light red, the legs dark red or with the femora infuscated. Small workers are black or very dark red, with the anterior part of the head paler.

The female measures 6–7 mm. The head is intermediate in size and shape between that of the female *sævissima* and *geminata*, the antennal scapes are also intermediate in length and the punctures on its upper surface are smaller than in *geminata* but more distinct than in *sævissima*. The mandibles have the same curvature as in the latter form. The coloration is that of the largest workers.

In the male the head is more opaque and punctate, as in the true *geminata*, and not so smooth as in *sævissima*, and the thorax has three broad, longitudinal red stripes.

I have seen large series of this ant from many localities in Central and Western Texas (Austin, Fort Davis, etc.), from Arizona (Phœnix, Huachuca Mts.) and Mexico (Guadalajara).

14. **Solenopsis geminata maniosa** subsp. nov.

Smaller than the other forms of *geminata* in all three phases, the worker measuring only 1.8–4.5 mm., the female 5–6 mm., the male 4–5 mm. The head of the largest worker is less rectangular and more rounded, owing to its distinctly more convex sides, the color is a rich light reddish yellow, with the posterior half of the gaster black and the borders of the gastric segments yellowish. The head, thorax and pedicel of the smallest workers are scarcely darker, with nearly the whole of the gaster black or dark brown.

In the female the head is rather rectangular, with straight posterior border, the mandibles are gradually curved, the antennal scapes reaching nearly to the posterior corners. The color is rich yellowish red, the mesonotum, except its middle line and the scutellum, brownish. In some specimens the whole gaster is black, with only the extreme base red, in others it is red with a broad black band across each segment. These bands are sometimes connected by a longitudinal middorsal stripe of the same color.

This is the common and perhaps the only form of *geminata* in Southern California. I have taken it in large colonies under stones and in diffuse and irregular crater nests in dry deserts and arroyos in the following localities; San Ysidro, near Santa Barbara (type locality), Pasadena, Claremont, La Jolla, San Diego, and Needles, and have received specimens from Los Gatos, Mt. Diablo Range (J. C. Bradley), Whittier (H. L. Quayle), Visalia (Culbertson), Jacinto Barranca, Fresno County (J. C. Bradley),

Eaton's Cañon, Los Angeles County, Fresno, Brookdale and Friant (R. V. Chamberlin). I have also met with it in Arizona (Tucson, Tempe, Benson) and have received specimens from Thatcher (R. V. Chamberlin) in the same state, from Alamito, New Mexico (G. von Krokow) and Ojos del Diablo, in Chihuahua, Mexico (C. H. Tyler Townsend).

As a result of the study of my material I submit the following arrangement of the species, subspecies and varieties of *Solenopsis* of the *geminata* group:

1. *Solenopsis geminata* Fabricius
   - var. *diabola* Wheeler
   - var. *nigra* Forel
   - subsp. *medusa* Mann subsp. nov. (in MS.)
   - subsp. *rufa* Jerdon
     - var. *micans* Stitz.
   - subsp. *xyloni* MacCook
   - subsp. *maniosa* subsp. nov.
   - subsp. *sævissima* F. Smith (= *pylades* Forel)
     - var. *richteri* Forel
     - var. *incrassata* Forel
     - var. *tricuspis* Forel
     - var. *quinquecuspis* Forel
   - subsp. *electra* Forel.
2. *Solenopsis aurea* Wheeler
   - subsp. *amblychila* subsp. nov.
3. *Solenopsis gayi* Spinola.

15. **Pheidole longipes** *Pergande.*

This interesting species was originally described by Pergande from Lower California as a race (subspecies) of *Ph. susannæ* Forel, and is evidently the form mentioned as a variety of this ant by Emery in his "Beiträge" (p. 297) as occurring in California. I possess a worker cotype from the Pergande collection and also a worker from Emery taken at San Jacinto, Cala. Forel has shown that *longipes* is an independent species quite distinct from *susannæ*. During the winter of 1910 I found *longipes* in several localities in the vicinity of San Diego, California, especially at La Jolla and Lakeside. It makes rather large mound-nests not unlike those of *Ph. morrisi* Forel in the South Atlantic States. The female (deälated), which has not been described, measures nearly 6 mm. and is of a deeper ferruginous red color than the soldier, with paler and more yellowish legs. The whole body, including the gaster, is opaque, with only the borders of the mandibles and frontal area shining. The epinotum has a broad median impression and bears a pair of moderately large spines, which are laterally compressed

and fully as long as broad at their bases; the postpetiole is nearly twice as broad as long, with bluntly conulate lateral borders. The pubescence is sparse but distinct, especially on the gaster. The surface of the thorax is densely rugulose-punctate, the pedicel and gaster densely and finely punctate, with larger, sparser piligerous punctures. The scuplture of the head resembles that of the soldier but is much coarser and the longitudinal rugæ are longer and more prominent. In the worker the epinotal spines are distinctly longer than in the cotype from Lower California, and additional material from this locality may show that the Californian form is a distinct variety.

16. **Pheidole militicida** sp. nov.

Soldier. Length 8 mm.

Head large, subcordate, scarcely longer than broad, distinctly broader behind than in front, with very deeply and angularly excised posterior border, in profile moderately convex above and below, the greatest depth being in the middle; cheeks slightly concave; eyes small, about $\frac{1}{4}$ the length of the head from the anterior corners. Occipital furrow deep. Mandibles very convex, bluntly bidentate at their tips. Clypeus short, flat, ecarinate, its anterior border distinctly notched in the middle. Frontal area elongate, deep, triangular, smooth, without a median carinula. Frontal carinæ short, strongly diverging. Antennæ small, slender; scapes much curved but not flattened at the base, reaching only as far as the eyes, joints 2–8 of the funiculus slightly longer than broad, club shorter than the remainder of the funiculus, its two basal joints subequal, together a little longer than the terminal joint. Thorax robust, with rather prominent, rounded humeri, the distance between which is less than half the width of the head; pro- and mesonotum forming together a subspherical mass in profile, the mesonotum being without a transverse constriction or torus. Mesoëpinotal constriction very deep. Epinotum short and high, its base in profile convex and passing into the sloping concave and somewhat longer declivity without a distinct boundary; spines stout, blunt, half as long as the distance between their bases, with slightly recurved tips, directed upward and somewhat outward and backward. Petiole from above but slightly longer than broad, with short, indistinct peduncle, broadest through the node, which is transverse, much compressed anteroposteriorly, with sharp, broadly excised border. Postpetiole somewhat less than twice as broad as the petiole, nearly twice as broad as long, forming above a low, anteroposteriorly compressed node, its sides produced in the middle as distinct conules. Gaster somewhat smaller than the head, flattened, broadly elliptical. Legs rather long and slender.

Shining; mandibles and posterior $\frac{2}{3}$ of head sparsely and rather finely punctate; sides of clypeus and anterior third of head sharply and rather finely longitudinally rugose, the rugæ between the frontal carinæ diverging posteriorly, those on the cheeks separated by punctate spaces. Base of epinotum transversely, its sides irregularly rugulose; anterior surface of postpetiolar node with a series of short, parallel grooves. Gaster and legs with scattered, piligerous punctures.

Hairs rather short, golden yellow, abundant, erect or suberect, covering the whole body, scapes and legs.

Reddish testaceous; gaster and legs yellow; borders of mandibles, anterior border of head and occipital groove black.

Worker. Length 3–3.5 mm.

Head subrectangular, as broad as long, with nearly straight posterior border and very feebly convex sides, with the eyes just in front of the middle. Mandibles with oblique blades furnished with two large apical and several smaller basal teeth. Clypeus convex, with entire, rounded anterior border. Antennæ similar to those of the soldier, but with the scapes extending a little beyond the posterior corners of the head. Thorax differing from that of the soldier in being more slender, with the mesonotum and base of epinotum long and rather straight in profile and the spines reduced to minute, erect teeth. Petiolar node compressed, sharp and transverse as in the soldier, but the border, seen from behind, is straight and entire. Postpetiole about twice as broad as the petiole, rounded in front above, without lateral conules, the sides rather straight behind, in profile feebly convex above. Gaster a little smaller than the head.

Shining; mandibles somewhat opaque; their bases and the cheeks longitudinally rugulose and punctate; sides of meso- and epinotum irregularly rugulose-punctate.

Hairs white, long, of unequal length, moderately abundant, erect on the body, on the legs and scapes shorter and more oblique.

Black; mandibles brownish yellow, with black teeth; clypeus, antennæ, tarsi, funiculi, articulations of legs and posterior borders of gastric segments brown.

Described from several soldiers and workers taken from a number of colonies in the desert at Hereford and Benson (alt. 3600 ft.), in Southern Arizona. This species is very closely related to *Ph. macclendoni* Wheeler, but both the soldier and worker are larger, the former is monomorphic, has the frontal area distinct and the rugosity not extending so far back on the head and the petiole and postpetiole are of a different shape when seen from above, the latter being larger, rounded above and with blunter sides, the thorax is more extensively sculptured, etc. The workers of the two species are more similar, but besides the difference in size, that of *macclendoni* is brown, with darker head and gaster.

The nests of *Ph. militicida* are small craters, 3–5 inches in diameter. When I found them at Hereford and Benson during November 1910, they were covered with masses of chaff, showing that the ant is a true harvester. Only workers could be obtained by the most diligent excavation of the nests, but among the chaff on nearly all the craters the workers had deposited numerous heads and dismembered bodies of soldiers. Mr. W. M. Mann, who collected at Hereford during August took living soldiers in the nests and from his specimens the foregoing description of the soldier is drawn. It appears, therefore, that all the individuals of this caste are regularly killed off by the workers on the approach of winter, probably after they have broken open all the hard seeds collected by the workers. Such a slaughter of the members of a large caste during a season when their activities are no longer required, when they would simply be a burden on the colony by con-

suming stored food and when fresh food cannot be collected, must have great advantages. Although I have never noticed this behavior in other species of *Pheidole,* I believe that a study of the harvesting species with very large-headed soldiers in the deserts of the southwest may bring other similar cases to light.

17. **Pheidole spadonia** sp. nov.

Soldier. Length 4–4.5 mm.

Head very large, subrectangular, 1⅓ times as long as broad, distinctly broader in front than behind, with straight sides and rounded posterior lobes, separated by a deep occipital excision, which is continued forward as a pronounced occipital groove to the middle of the head. In profile it is most convex in the middle and distinctly compressed dorso-ventrally behind. Eyes rather small, flattened, at the anterior fourth of the sides. Mandibles very convex, with two large apical and one or two small basal teeth. Clypeus very short, its anterior margin broadly excised in the middle, its central portion feebly convex but not carinate. Frontal area triangular, rather deep. Frontal carinæ short, diverging. Antennæ very small and slender, the scapes curved but not flattened at the base, not reaching to the eyes; funicular joints 2–8 distinctly longer than broad; club shorter than the remainder of the funiculus, its two basal joints subequal, together as long as the terminal joint. Thorax short, robust, through the prominent humeri not more than half as broad as the head. In profile the pronotum is rather straight and sloping, forming a blunt obtuse angle with the mesonotum, which is of the same length and slopes backward at a slighter inclination but terminates near the mesoëpinotal suture in a sharp, narrow, transverse torus with abrupt, concave posterior slope. Epinotum with subequal base and declivity, the latter sloping, concave; spines rather slender and pointed, as long as broad at their laterally compressed bases, twice as far apart as long, directed upward and outward. Petiole from above with extremely short peduncle, subrectangular, as broad in front as behind, with sharp anterior angles; in profile the node has a long concave anterior and abrupt, straight posterior surface, its border is transverse, rather sharp and feebly excised in the middle. Postpetiole nearly 3 times as broad as the petiole and four times as broad as long, its sides produced as prominent pointed projections with convex anterior and concave posterior borders. Gaster broadly elliptical, much smaller than the head, somewhat flattened dorso-ventrally. Legs rather long, with stout femora.

Shining; mandibles smooth, with sparse and very small piligerous punctures; clypeus smooth and shining in the middle, longitudinally rugulose on the sides; anterior half of head very sharply, longitudinally rugulose, the rugæ on the front distinctly diverging, those on the cheeks parallel. Posterior half of head, pro- and mesonotum smooth and shining, with very small, scattered piligerous punctures; metanotum feebly and indistinctly rugulose-punctate, the declivity of the epinotum between the spines finely transversely rugulose. Petiole and postpetiole with fine, dense, shallow punctures on the sides so that these parts appear a little more opaque. Gaster smooth and shining, with fine, scattered, piligerous punctures.

Hairs golden yellow, coarse, of unequal length, rather long and abundant, suberect; longer and more reclinate on the gaster, shorter and oblique on the legs and scapes.

Testaceous yellow; legs a little paler; mandibles and clypeus deep red, with black borders; petiole and postpetiole brownish, gaster also faintly tinged with brown.

Worker. Length: 1.5 mm.

Head as broad as long, subrectangular, with feebly convex sides and feebly excised posterior border; anterior clypeal margin entire, broadly rounded. Antennal scapes reaching a little beyond the posterior corners. Pro- and mesonotum together convex and evenly rounded above, the latter without a torus. Base of epinotum feebly convex, longer than the declivity; spines reduced to small, slender, erect teeth. Petiole from above twice as long as broad, with concave sides; node rounded, entire; postpetiole about $\frac{1}{3}$ again as broad as the petiole, convex and rounded above, transversely elliptical, distinctly broader than long. Gaster about the size of the head.

Smooth and shining; mandibles finely striato-punctate; cheeks longitudinally rugulose. Mesopleuræ, epinotum and petiole slightly opaque, densely punctate.

Pilosity similar to that of the soldier, but hairs on the body more obtuse. Color like that of the soldier but the head and thorax more brownish; mandibles and clypeus not darker than the anterior portion of the head; legs and antennæ yellowish.

Described from six soldiers and nineteen workers taken on the banks of the Santa Cruz River at Tucson, Arizona. The nests were incomplete craters in sandy soil exposed to the sun, with small entrance and the excavated sand dumped to one side. Only one or two soldiers were found in a nest. The species is apparently carnivorous.

This ant at first sight seems to be very closely related to the South American *Ph. stulta,* but the soldier is at once distinguished by the absence of a carina on the clypeus and considerable differences in the shape of the petiole and postpetiole. The worker is much smaller than that of *stulta,* with much shorter antennal scapes, longer epinotal spines, shorter thorax, etc.

18. **Pheidole virago** sp. nov.

Soldier. Length 4–4.5 mm.

Head very large, about $\frac{1}{4}$ longer than broad, distinctly broader behind than in front, with straight sides, and prominent, rounded posterior lobes, separated by a very deep occipital excision continued forward nearly to the frontal area as a deep groove. In profile the head is convex above and below and very slightly compressed in the region of the posterior lobes. Eyes rather small and flat, near the anterior fourth of the head. Mandibles very convex, with two blunt apical teeth. Clypeus very short, its anterior border feebly and sinuately excised in the middle, median surface feebly convex, with indistinct carina. Frontal area distinct, broadly triangular. Frontal carinæ short, diverging. Antennæ small and slender; scapes curved, but not flattened at the base, not reaching to the eyes; funicular joints 2–8 subequal, a little longer than broad; club shorter than the remainder of the funiculus, the two basal joints subequal, together a little longer than the terminal joint. Thorax

very short and robust, narrower through the prominent but rounded humeral angles than half the head; pronotal surface in profile slightly convex, sloping anteriorly; mesonotum straight and sloping backward, with a distinct but blunt torus near its posterior margin; epinotum as broad as long; base and declivity in profile subequal, the latter sloping; spines stout, blunt, half as long as the base and half as long as their distance apart at the base, directed upward and slightly outward and backward. Petiole from above with very short peduncle, $1\frac{1}{2}$ times as long as broad, somewhat broader behind through the node, which is transverse, with long, concave anterior and short, abrupt posterior declivity, the border rather sharp and distinctly excised in the middle. Postpetiole more than twice as broad as the petiole and nearly 3 times as broad as long, its sides produced as blunt points with convex anterior and concave posterior borders. Gaster much smaller than the head, broadly elliptical and somewhat flattened. Legs long, with moderately thickened femora.

Shining; mandibles with a few coarse punctures near the apical borders and smaller, scattered punctures on the remaining surface. Clypeus longitudinally rugulose even in the middle. Anterior $\frac{2}{3}$ of head with rather sharp, fine longitudinal rugæ, those on the front diverging; posterior third smooth, with much scattered, coarse and rather elongated punctures. Pro- and mesonotum transversely, mesopleuræ and sides of epinotum longitudinally rugulose; concave declivity of epinotum between the spines indistinctly and finely transversely rugulose. Petiole and postpetiole slightly opaque, upper surface of latter with a row of large, elongate, piligerous punctures. Gaster shining, minutely shagreened and with scattered piligerous punctures.

Hairs yellow, rather coarse, suberect, of unequal length, moderately abundant, scarcely longer on the gaster than on the head; shorter and somewhat more oblique on the legs and antennal scapes.

Head yellowish red; mandibles dark red, their borders and the sides and anterior border of the clypeus blackish; thorax and pedicel brown, the postpetiole darker; gaster black, with brown posterior borders to the segments; legs brownish yellow; antennæ scarcely paler than the head.

Worker. Length: 1.5 mm.

Head a little longer than broad, subrectangular, with feebly convex sides and straight posterior border, feebly notched in the middle. Anterior border of clypeus entire, broadly rounded. Antennal scapes reaching a little beyond the posterior corners of the head. Thorax broad through the pronotum, with rather prominent humeri; pro- and mesonotum in profile convex and rounded above, the latter without a torus; epinotal base longer than the declivity; spines small, slender, erect and rather blunt at their tips. Petiole nearly three times as long as broad, with concave sides, its node narrow, with blunt, entire upper margin. Postpetiole less than twice as broad as the petiole, nearly as long as broad, convex above, with feebly angular sides. Gaster somewhat smaller than the head.

Mandibles, head, thorax and pedicel subopaque; gaster shining; mandibles striatopunctate; clypeus and head longitudinally rugulose, the latter with finely punctate interrugal spaces; thorax and pedicel finely and densely punctate; pronotum above vermiculately or reticulately rugulose-punctate.

Hairs whitish, sparse and erect on the body, much shorter and more appressed on the appendages.

Brown, with slightly paler appendages; gaster black, with brown posterior margins to the segments.

Described from six soldiers and six workers, taken in the valley of the Santa Cruz River, near Tucson, Arizona, in the same place as the preceding species. The colonies were small and contained very few soldiers. Like the preceding this species is probably carnivorous. The nests were perfect craters, 3–5 inches in diameter, with a large central opening half an inch in diameter.

Pheidole virago is related to *Ph. guilelmi-muelleri* Mayr and *androsana* Whlr., but the sculpturing of the head of the soldier is more extensive and of a different character in both of these species, and the antennal scape in *guilelmi-muelleri* is dilated and flattened, while *androsana* has a smooth, differentiated, scrobe-like area for the antennal scape and the frontal carinæ are prolonged backwards.

19. **Pheidole fimbriata** *Roger.*

Some years ago I described a large deälated female *Pheidole* taken by Oslar at Nogales, Southern Arizona, as *Ph. rhea.* More recently I received from Dr. A. G. Ruthven several winged specimens of this same ant from Cuatololapan, Vera Cruz, Mexico, accompanied by the soldiers and workers. The latter prove on examination to be specimens of *Ph. fimbriata* Roger, a species widely distributed through tropical America, so that the name *rhea* must be relegated to the synonymy. The wings of the female are nearly 16 mm. long, heavily infuscated, with dark brown veins and stigma.

20. **Pheidole tepicana cavigenis** subsp. nov.

Soldier. Differing from the typical *tepicana* Pergande in the shape and sculpture of the head, the shape of the pedicel and in color. The head is proportionately shorter and the sides are straight and subparallel (in *tepicana* feebly convex) but distinctly concave at and in front of the eyes, with the anterior angles prominent and everted. The eyes are distinctly larger and more convex, the rugæ on the front and sides of the head are more distinct, but the transverse rugæ on the occiput are feebler and more reticulate. The petiolar node is perceptibly emarginate (entire in *tepicana*), and the postpetiole is decidedly broader. The thorax and petiole are concolorous with the head, the mesonotum infuscated and the vertex with a black spot.

Described from three specimens (one immature) taken from a single small colony in Miller Cañon, Huachuca Mts., Arizona (5600 ft.). These have been compared with Mexican specimens of a form which agrees very closely with Pergande's *tepicana*, except in color.

21. **Pheidole kingi torpescens** subsp. nov.

Soldier. Differing from that of *kingi* and its subspecies *instabilis* Emery in the shape of the head, which is distinctly shorter in proportion to its width and decidedly broader behind than in front (if anything broader in front than behind in *kingi* and *instabilis*), with the occipital excision deeper and the occipital groove broader. The intermediates also have the same type of head, whereas in the forms previously mentioned it is distinctly broader in front than behind. In *instabilis* the head is darker in color, while in *torpescens* it is uniformly ferruginous red as in the soldier.

Worker. Colored like the worker of the true *kingi* and therefore paler than in *instabilis*, with the antennal scapes extending well beyond the posterior corners of the head as in that form (in *kingi* reaching only a little beyond the posterior corners). The epinotum bears minute spines or teeth as in *kingi*. These are reduced to mere angles in *instabilis*.

Described from single soldier and worker specimens and two intermediates taken from a small nest under a stone near the Carnegie Desert Laboratory at Tucson, Arizona.

22. **Pheidole xerophila pacifica** subsp. nov.

Soldier. Differing from the typical *xerophila* Wheeler in the following particulars: the head is slightly broader behind, much less punctate on its posterior $\frac{3}{5}$ and therefore as in the subsp. *tucsonica* Wheeler and of a deeper red color, with a black spot on the vertex. The sculpture of the thorax is much as in the typical *xerophila*, with the pronotum shining, but the petiolar node is excised as in *tucsonica*. The epinotal spines are more slender and somewhat longer than in either of the previously described forms. The thorax, pedicel and gaster are dark chestnut brown or blackish, the legs and posterior edges of the gastric segments yellowish brown.

Worker. Differing from the workers of *xerophila* and the subsp. *tucsonica* especially in the sculpture of the head and in the paler color. The head is subopaque or shining only on the vertex, not glabrous behind the cheeks but with the whole upper surface delicately longitudinally rugulose and reticulate-punctate. Specimens vary from light to dark castaneous brown, the head and thorax being sometimes nearly black, the mandibles, clypeus, antennæ and legs light yellowish brown.

Female. Length: 5.5–6 mm.

Head subrectangular, broader than long, broader behind than in front with straight sides and posterior border. Antennal scapes reaching halfway between the eyes and the posterior corners of the head. Thorax as broad as the head, flattened above, base of epinotum half as long as the declivity; spines stout, as long as broad at their bases. Petiole similar to that of the soldier, postpetiole about twice as broad as the petiole, and nearly twice as broad as long, its sides produced in the middle as two rather blunt points. Gaster suboblong, more than twice as long as broad, flattened dorsoventrally. Wings long (nearly 7 mm.).

Mandibles shining, coarsely and sparsely punctate. Head opaque, longitudinally rugose, with punctate or reticulate interrugal spaces. Thorax and gaster

shining; pronotum transversely rugose, mesonotum, scutellum and mesopleuræ coarsely and sparsely punctate, mesonotum also with a patch of longitudinal rugæ near its posterior margin. Epinotum, petiole and postpetiole opaque, densely punctate. Gaster with fine piligerous punctures.

Hairs more abundant than in the soldier, but more appressed, short and inconspicuous on the appendages.

Head ferruginous red, borders of mandibles and an ocellar spot black. Remainder of body deep castaneous brown, pleuræ and posterior borders of gastric segments paler; antennæ and legs brownish testaceous. Wings grayish hyaline, with pale brown veins and dark brown stigma.

Male. The head is opaque and densely longitudinally rugulose and punctate (shining in the male *xerophila*), the veins of the wings are somewhat darker and the petiolar node is higher and somewhat more acute in profile than in the type of the species.

Described from numerous specimens of all four phases taken at Pasadena and Lakeside, Southern California, during late November, 1910. The colonies were found on the dry open hills in small crater nests, the periphery of which was often covered with discarded chaff and seeds, proving that the species is a harvester. Only a few soldiers were found in each nest. The presence of males and winged females in late November shows that these phases are probably retained in the nests throughout the winter as in *Prenolepis imparis, Camponotus americanus* etc., and that the nuptial flight as in these ants probably occurs in the very early spring.

23. **Pheidole vinelandica longula** *Emery* var. **castanea** var. nov.

Differing from the typical *longula* in its much darker coloration, the body of the soldier being rich chestnut brown, the anterior border of the gaster, the posterior border of the head, the cheeks, disks of mandibles, clypeus, legs, antennæ, pleuræ and epinotum somewhat paler and more reddish. The coloration of the worker is similar, except that the posterior portion of the head and the anterior portion of the gaster are dark like the remainder of these regions.

Described from six soldiers and thirteen workers taken in Miller Cañon, Huachuca Mts., Arizona, at an altitude of 6000 ft.

24. **Pheidole vinelandica cerebrosior** subsp. nov.

Soldier. Like the typical *vinelandica* in color, sculpture and pilosity, but the head decidedly larger though not proportionally longer, and with the postpetiole twice as broad as the petiolar node and produced on the sides as pointed conules.

Worker. Differing from the worker of the typical *vinelandica* only in having the fine punctuation of the thorax and pedicel stronger and these parts therefore more opaque and the erect hairs somewhat less abundant and more obtuse at their tips.

Described from thirteen soldiers and ten workers taken in the dry desert near Tucson, Arizona.

25. **Pheidole californica** *Mayr.*

Considerable series of this ant collected in various localities in California enable me to state that Emery's account of its characters and of those of his *oregonica* needs revision. He states that the transverse rugæ on the back of the head of the soldier of *californica* pass over on the sides into the longitudinal rugæ (of the cheeks), but this is not implied in Mayr's description, it is not the case in a typical specimen of *californica* which Emery kindly sent me many years ago nor is this condition apparent in any of the numerous specimens I have since seen.

The *soldier* of the species measures 2.3–2.5 mm. and may be readily recognized by the following characters: The head is decidedly longer than broad, a little broader behind than in front, with feebly convex sides, flattened above and below, with its greatest dorsoventral diameter through the eyes, the posterior orbits of which are at the anterior third of the head. The transverse occipital rugæ are coarse and reticulate as Mayr states, and terminate on the posterior corners. The anterior third of the head is strongly, longitudinally rugose and between this sculptured region and the posterior rugæ the surface is very shining and sparsely and coarsely punctate. The thorax is densely punctate and shagreened and subopaque, with the exception of the pro-mesonotal convexity, which is smooth and shining. The postpetiole is, as stated by Emery, trapezoidal, broadest through its anterior corners, which are rounded. Specimens of the typical coloration are rufo-testaceous, with the legs yellow and the gaster somewhat infuscated. The hairs are yellowish, rather long and abundant, of uneven length on the body, suberect on the body and scapes, short and subappressed on the legs.

The *worker* measures 1.6–2 mm., has the head very smooth and shining, the thorax sculptured as in the soldier, the postpetiole small and subglobular, the epinotal spines small, as long as broad at the base. Pilosity similar to that of the soldier but sparser. Coloration rufotestaceous, upper surface of head and gaster dark brown; legs, clypeus, mandibles and antennæ yellow.

The *female* (deälated) measures nearly 4 mm.

Head about as broad as long, subrectangular with straight sides and broadly excised posterior border, rather convex above. Antennal scapes reaching to half the distance between the eyes and the posterior corners. Thorax as broad as the head, oval, narrowed behind, the mesonotum and scutellum very flat. Epinotal spines short, triangular, acute. Petiolar node in profile acute, its border seen from behind straight, transverse and entire. Postpetiole less than twice as broad as the petiole, broader than long, with blunt lateral conules. Gaster elongate elliptical.

Head longitudinally and coarsely rugose, except the occiput, which is transversely rugose and very coarsely punctate. Thorax opaque and densely punctate, except the mesonotum and scutellum, which are smooth and shining, with a few sparse punctures. Petiole and postpetiole opaque and densely punctate, except the node

of the latter, which is smooth and shining. Gaster shining, with fine, sparse, piligerous punctures.

Pilosity similar to that of the soldier but shorter and more uniform; hairs on the legs and antennal scapes more appressed.

Rufotestaceous; legs somewhat paler; mandibles, gaster and anterior portion of head darker and brownish, posterior margins of gastric segments yellowish.

Described from numerous soldiers and workers and one female from the following localities in California: Palo Alto (H. Heath and W. M. Mann and Wheeler); Brookdale and Santa Cruz Island (R. V. Chamberlin). The type locality is San Francisco (Schaufuss).

26. **Pheidole californica** *Mayr* var. **incenata** var. nov.

Slightly smaller than the typical form and differing in color, the whole body being yellow in the soldier and worker, except the mandibles and sides of the clypeus in the former, which are red, and the top of the head of the latter, which is somewhat infuscated.

Nine soldiers and as many workers taken by Prof. H. Heath at Palo Alto, California.

27. **Pheidole californica** *Mayr* var. **satura** var. nov.

Fully as large as the type but differing from it and the var. *incenata* in color. The soldier has the mandibles, head, thorax, and pedicel deep chestnut brown, the borders of the mandibles and the gaster black, the legs brownish yellow with the middle portions of the femora infuscated. The worker has the head, gaster and pronotum deep castaneous, the remainder of the thorax, mandibles, the pedicel, clypeus, antennæ and legs brownish yellow, the femora darker, except at their bases and tips.

Described from numerous soldiers and workers taken on Santa Cruz Island, California, by Dr. Ralph V. Chamberlin and at Palo Alto, Cala., by Prof. H. Heath.

28. **Pheidole californica oregonica** *Emery.*

Emery described this ant as a species, but I believe that it is no more than a subspecies bearing the same relation to the typical *californica* that the typical *Ph. vinelandica* Forel bears to its subspecies *longula* Emery. The head of the *oregonica* soldier is distinctly shorter in proportion to its width than that of *californica*, and the frontal and occipital rugæ are sharper

and finer; the latter are not reticulate, and the punctures on the smooth portions of the head are much finer and less conspicuous. The postpetiole has more acute anterior angles. There is some variation in color, but none of my specimens is as dark as those described by Emery. I am unable to distinguish the workers of this form from those of *californica* by any reliable characters. Three females (deälated) measure 3.5 mm. and differ from the same sex of *californica* in having the head less coarsely sculptured and the post-petiole with more acute and longer lateral conules. The body is reddish testaceous, with a large spot on the ocellar region, three longitudinal bands on the mesonotum and the gaster behind the first segment, dark brown; legs yellowish.

Numerous specimens from the following localities; Marion County, Oregon (P. J. Schmitt), Almota, Washington (A. L. Melander); Wawawai and Pullman, Washington (W. M. Mann); and Julietta, Idaho (J. M. Aldrich).

29. **Pheidole californica nevadensis** subsp. nov.

Soldier. Resembling the typical *californica* in coloration and the shape of the head, but its sculpture is more like that of *oregonica*, with sharp, more reticulate and slightly more delicate occipital rugæ and feebler punctures on the smooth area. The thorax, however, is smooth and shining throughout, even the epinotum and the anterior corners of the postpetiole being rather sharp as in *oregonica*. In the worker the antennal scapes do not reach beyond the corners of the head and are therefore decidedly shorter than in either *californica* or *oregonica*. The thorax is smooth and shining even in the epinotal region as in the soldier. A single deälated female measures only 3.5 mm. The head is more shining and less heavily sculptured than in *californica* and the cones of the postpetiole are less produced than in *oregonica*. The body is rufo-testaceous, with a spot on the ocellar region, the mesonotum, scutellum, pedicel, and gaster castaneous. Antennæ and legs yellow, the middle portions of the femora brown.

Described from a female, four soldiers and five workers taken by Mr. W. M. Mann at Pyramid Lake, Nevada.

30. **Pheidole californica micula** subsp. nov.

Soldier. Length: 2.4–2.6 mm.

Head narrower and smaller than in the typical *californica*, with shallower occipital excision and more rounded occipital lobes, the rugæ and punctures on the head very fine and indistinct so that its whole surface is more shining; the occipital rugæ, however, very sharp and regular, not reticulate. Thorax and pedicel subopaque, very finely and densely punctate, humeri with a few rugules, pro- and mesonotum above rather smooth and shining. Gaster glabrous and shining. Epinotal spines and

anterior angles of postpetiole very blunt. Color yellow; gaster, legs and antennæ paler, mandibles often reddish, their borders and the anterior edge of the clypeus black.

Worker. Length: 1–1.3 mm.

Head more rectangular, with less convex sides than in the preceding forms; antennal scapes not extending beyond the posterior corners of the head. Sculpture of thorax and petiole as in the soldier; head very smooth and shining. Color yellow, mandibles, clypeus, antennæ and legs somewhat paler, dorsal surface of head slightly brownish.

Six soldiers and six workers taken from a single colony in Miller Cañon, Huachuca Mts., Arizona (5300 ft.). This may be a distinct species, but for the present I prefer to regard it as a very pronounced subspecies of *californica*.

31. **Pheidole hyatti solitanea** subsp. nov.

Soldier. Length 3–3.3 mm.

Even darker in color than the var. *ecitonodora* Wheeler; legs brown; decidedly smaller than this variety and the type of the species, and with the antennal scapes considerably longer, so that they reach nearly to the posterior corners of the head, epinotal spines a little more slender.

Worker. Length 2 mm.

Smaller than the worker of *hyatti* and the var. *ecitonodora*, with the posterior portion of the head and upper portion of the pronotum more glabrous and shining, and without rugules and punctures.

Female. Length: 4.5–5 mm., wings 6 mm.

Very small compared with the female of other forms of the species. Red; gaster dark brown, reddish at the base of the first segment; posterior borders of segments yellowish; antennal scapes reaching a little beyond the posterior corners of the head, somewhat less dilated at the base than in other forms of the species.

Described from seven soldiers and seven workers taken by myself on Point Loma, near San Diego, California, and a single soldier and three females taken by Mr. Percy Leonard in the same locality.

32. **Pheidole crassicornis vallicola** subsp. nov.

Soldier. Length: 3.5–4 mm.

Differing from the typical *crassicornis*, its var. *diversopilosa* Whlr. and its subsp. *porcula* Whlr. with the var. *tetra* Whlr. in sculpture, pilosity and coloration. The mandibles are coarsely striatopunctate over their whole upper surface, the clypeus is subopaque and rugulose in the middle, and the reticulate rugæ on the anterior portion of the head are coarser. The pronotum above is shagreened and rugulose and only slightly shining, the postpetiole densely punctate and subopaque like the petiole.

The pubescence on the head, gaster, and appendages though sparse, is long and conspicuous; the erect hairs are long, pointed and very sparse, but conspicuous on the occiput, thorax, pedicel and gaster. Both hairs and pubescence are pale yellow. The body is dark chestnut brown, the mandibles, except their borders, the middle of the clypeus and the cheeks and front are deep red. Antennæ dark brown, legs paler brown.

Worker. Length: 2.3–2.5 mm.

Deep castaneous, head and gaster darker, mandibles, clypeus and legs reddish brown; punctuation of the head, thorax and pedicel coarser and deeper than in the typical *crassicornis*, only a median streak on the head and a small median spot on the thorax shining. Erect hairs more abundant than in the soldier, of uneven length and pointed; scapes with a few suberect hairs, legs with numerous more oblique hairs.

Described from seven soldiers and eleven workers taken in Miller Cañon, Huachuca Mts., Arizona (alt. 5000 ft.).

33. **Stenamma brevicorne heathi** subsp. nov.

Worker. Differing from all the known North American forms of *brevicorne* in sculpture and in its much paler color. The insect is light ferruginous red throughout, the legs and gaster very slightly paler than the head and thorax. Some specimens have a vague brownish spot on the vertex. The occiput and upper surface of the thorax are slightly shining. The rugæ of the pro- and mesonotum are coarse and reticulate and without longitudinal trend as in the other forms. Rugæ of the post-petiole similarly coarse and reticulate. Spines of the epinotum very acute, fully as long as broad at their bases. Peduncle of petiole with a small tooth anteriorly on the ventral side. Eyes small, with not more than four ommatidia in their greatest diameter. Antennal scapes a little longer than in *brevicorne* and its varieties and reaching very nearly to the posterior corners of the head.

Described from 25 workers taken from a single colony in King's River Cañon, California, by Prof. Harold Heath. This form may deserve to rank as a distinct species when the winged phases are discovered.

34. **Messor chamberlini** sp. nov.

Worker. Length: 4–4.3 mm.

Closely related to *M. andrei* Mayr, but much smaller, of a different color and with different petiole and epinotal spines. The pro- and mesonotum together are more convex and rounded above; the epinotal spines are not longer than the epinotal declivity, slightly curved, more rapidly tapering and more slender at their tips and directed somewhat more upward and less backward than in *andrei*. In profile the petiole has a lower and more rounded node and its ventral surface is straight or slightly concave in outline (in *andrei* with a distinct median protuberance). The sculpture is like that of *andrei*, but not so coarse and the general surface is a little

more shining. The hairs on the body are less abundant, those on the gula longer and forming a more distinct psammophore. The whole body is ferruginous red, except the middle portions of the femora and tibiæ and the gaster posterior to the middle of the first segment. These regions are dark brown or blackish. Mandibular and clypeal borders black.

Described from 18 workers taken by Dr. R. V. Chamberlin on Santa Cruz Island, off the coast of Southern California.

35. **Aphænogaster subterranea valida** subsp. nov.

Worker. Length: 4–5.5 mm.

Differing from the subsp. *occidentalis* Emery in the more robust build of the large workers, the broader head, slightly shorter antennal scapes, heavier sculpture and much darker color. The rugosity and punctuation of the head, pleuræ and epinotum are much coarser, so that these parts and especially the epinotum are subopaque. The occiput and dorsum of the pro- and mesonotum are shining, but the mesonotum is distinctly shagreened (smooth in *occidentalis*). The epinotal spines are somewhat longer and stouter than in this subspecies. The head, thorax, petiole and gaster are deep chestnut brown, the legs and articulations of the tarsi, the neck, clypeus, frontal carinæ, antennæ, mandibles and sutures of the thorax deep red; middle portions of the femora and tibiæ somewhat darker.

Female. Length: 6–6.5 mm.

Differing from the female of *occidentalis* only in the somewhat broader and more rectangular head, slightly shorter antennal scapes and darker color. In both subspecies the mesonotum and scutellum are very smooth and shining, and the wings are long and hyaline, with pale yellow veins and brown stigma.

Male. Length: 4–5 mm.

Indistinguishable from the male of *occidentalis* except in the slightly darker and more blackish color of the body and the more distinctly shagreened though scarcely less shining mesonotum. Wings colored as in the female.

Described from seven females, five males and numerous workers taken from two colonies in Cheyenne Cañon, near Colorado Springs, Colo. These colonies were very populous and were nesting under huge stones, and one of them was beginning its nuptial flight when I came upon it. There is a distinct tendency to polymorphism in the worker caste, the smaller individuals closely resembling the only worker phase of the subsp. *occidentalis*. The colonies of the latter are very small compared with those of *valida*. I have compared this form with topotypes of *occidentalis* taken by Mr. W. M. Mann at Pullman, Washington and with long series of specimens from other localities in that state, Oregon, California, Utah, Colorado, Idaho and Montana.

36. **Aphænogaster subterranea borealis** subsp. nov.

Worker. Length: 4.5–5.5 mm.

Differing from *valida, occidentalis* and the typical *subterranea* in sculpture and coloration. The whole head is rugulose-punctate so that the occipital region is not or only very slightly shining. The pro- and mesonotum, too, are subopaque and densely punctate. The antennal scapes are of the same length as in the other subspecies, except *valida*. The gaster and nodes of the petiole and postpetiole are deep chestnut brown, the remainder of the body light brown, the head, especially behind, somewhat darker, the legs a little paler.

Described from 13 workers taken by Prof. J. Chester Bradley at Lardo, Kootenay Lake, British Columbia.

37. **Aphænogaster mutica** *Pergande.*

This species was originally described by Pergande from San Jose del Cabo at the tip of Lower California. Dec. 16, 1901, I took a single worker specimen at Terlingua, Brewster Co., Texas, in the Great Bend of the Rio Grande. I have also received two workers from Dr. C. H. Tyler Townsend who took them at Cerro Chilicote in Chihuahua, Mexico. All of these specimens agree perfectly with Pergande's description.

38. **Aphænogaster texana** *Emery.*

Emery described this ant from two workers as a variety of *A. fulva* Roger, but study of a large series of specimens of all three phases convinces me that it should rank as a distinct species, which is, however, almost halfway between *A. fulva* and *A. mutica* Pergande. The head of the worker *texana* is more slender than that of *fulva*, including the mandibles twice as long as broad, and narrowed behind the eyes, so that the occipital region is not nearly as broad as in *fulva* and without posterior corners. The eyes are distinctly larger, the antennæ decidedly longer, the scapes extending fully $\frac{1}{3}$ of their length beyond the posterior border of the head, the individual joints of the funiculi longer and more slender. The basal teeth of the mandibles are larger and more nearly of the same size as the apical teeth. The epinotum is longer, its spines are short, acute, directed upward and very slightly backward. The postpetiole is more voluminous, compared with the petiole, and its node is more rounded. The head and thorax are opaque and very densely punctate, the clypeus much smoother and more shining than in *fulva*,

the thorax, petiole and postpetiole uniformly and densely punctate and opaque, except the epinotum, which is somewhat rugulose on the sides. The color is uniformly light ferruginous red, with slightly more yellowish gaster and legs. In some specimens the gaster is indistinctly infuscated posteriorly.

The female measures 11–11.5 mm. and is colored like the worker, the wings are yellowish hyaline, with pale yellow veins and brown stigma. They are longer than in *fulva*. The female *texana* differs from the female *fulva* also in the shape of the head, which is narrower behind and therefore more elliptical, the eyes are more convex and the antennæ distinctly longer, though their scapes do not reach so far beyond the posterior borders of the head as in the worker. The clypeus is finely rugulose-punctate and opaque as in *fulva*. The difference in the size of the postpetiole is even greater in the females of the two species.

The male *texana* measures 4–5 mm. and is much paler than the male *fulva*, being reddish brown, with the head dark brown, the mandibles, antennæ and legs light yellow, but the main difference is in the shape of the epinotum. The two protuberances of this region, representing the spines of the worker, are much inflated and bluntly rectangular in profile in *fulva*, whereas in *texana* they are much less swollen and acutely pointed.

I have frequently taken this ant nesting in rather small colonies under stones in shady woods and ravines about Austin and New Braunfels, Texas. A very similar form, but slightly darker in the worker phase and tending towards the variety described below, was collected in the Indian Garden on the Bright Angel Trail in the Grand Cañon, Arizona. Four workers received from Miss Anna Klaumann and taken at Douglas, Kansas (alt. 900 ft.) are indistinguishable from Texan specimens.

39. **Aphænogaster texana** *Emery* var. **furvescens** var. nov.

Worker. Differing from the typical form only in color, which is reddish brown, with the gaster dark brown, except at the extreme base. In some specimens the head and nodes of the petiole and postpetiole are also distinctly infuscated.

Female (deälated). Length: 7.5 mm.

Like the worker, differing from the female *texana* in color, the body being rich brownish red, the basal half of the gaster, wing-insertions and a broad V-shaped blotch on the head, with its apex on the vertex and its two limbs running forward between the eyes and frontal carinæ, blackish.

Several workers and a single female from two localities in the Huachuca Mts., Arizona, namely Miller Cañon, 5800 ft. (Wheeler) and Ramsay Cañon, same altitude (W. M. Mann).

40. **Aphænogaster texana** *Emery* var. **carolinensis** var. nov.

Worker. Length: 4–5 mm.

Averaging somewhat smaller than the typical *texana*, with the epinotal spines nearly as long but less erect and directed more backward. The ground color of the body is less red and more brownish, with the dorsal surface of the head, thorax, pedicel and gaster varying from light to dark brown, the base and tip of the gaster paler, antennæ ferruginous, legs yellow; sculpture of the head more pronounced than in *texana*.

Female (deälated). Length: 5.5 mm.

Decidedly smaller than the female *texana*, with narrower clypeal emargination, shorter thorax, and the petiolar node more acute in profile; gaster less voluminous, broadly elliptical. Color much as in the worker.

Described from a single female and numerous workers taken from several small colonies nesting under stones in open woods at Tryon, North Carolina.

41. **Leptothorax eldoradensis** sp. nov.

Worker. Length: 1.8 mm.

Head subrectangular, longer than broad. Mandibles 5-toothed. Clypeus with entire anterior border, which is straight in the middle and not produced, its upper surface impressed in front at the margin. Antennæ 12-jointed; scapes reaching to the posterior corners of the head; funicular joints 2–8 slightly broader than long; two basal joints of club together nearly as long as the terminal joint. Thorax rather short and robust, scarcely longer than the head with the mandibles, decidedly broader in front than behind, with rounded humeri, the sides of the meso- and epinotum subparallel. In profile the dorsal outline is convex in front, straight in the middle and sloping in the epinotal region, both the base and declivity of the latter being subequal and having the same slope; spines reduced to very small, acute teeth, which are shorter than broad at their bases. Petiole from above but little longer than broad, scarcely pedunculate, with straight, subparallel sides; in profile the node is rather high with angular summit, the anterior slope long and distinctly concave, the posterior short and abrupt. Postpetiole small, scarcely half again as broad as the petiole, a little broader in front than behind, convex and subelliptical in outline when seen from above. Gaster elliptical, with straight anterior border. Legs rather slender, the femora and tibiæ feebly clavate.

Head, thorax, pedicel and appendages subopaque, the head slightly shining on the vertex and occiput; gaster smooth and shining. Mandibles rather coarsely striato-punctate; clypeus with three strong median longitudinal carinæ or rugæ and numerous feebler rugæ on the sides. Head, thorax, petiole and postpetiole densely and evenly punctate; head also longitudinally rugulose. Legs and scapes more finely punctate-shagreened.

On the body the hairs are white, erect, obtuse but not clavate, and sparse; on the appendages they are delicate, pointed, appressed and more numerous.

Chestnut brown; gaster paler at the base; mandibles and legs yellowish brown; femora and tibiæ infuscated in the middle.

Described from two workers taken by Dr. J. C. Bradley on the summit of Mt. Wilson, near Pasadena, California. This species may be mistaken for *L. neomexicanus* Wheeler, but it is smaller, the thorax is stouter and of a different shape, the epinotal spines are much shorter, the petiolar node more acute in profile and the postpetiole decidedly smaller.

42. **Leptothorax (Mychothorax) hirticornis formidolosus** subsp. nov.

Worker. Length: 2.5–2.75 mm.

Agreeing with Emery's description of the typical *hirticornis*, except in the following particulars: The spines of the epinotum are not compressed, the petiolar node is scarcely angular but rounded in profile, the color in mature specimens is darker, the body being brownish ferruginous, the upper surface of the head and the gaster, except the extreme base and tip of the latter, dark brown. The legs and antennal scapes are opaque and densely punctate like the thorax. The tips of the mandibles, the clypeus along the middle line and posteriorly and a short median line on the front are shining. The postpetiole is distinctly broader than long, trapezoidal, with its anterior broader than its posterior border and its sides straight. The gaster is regularly elongate elliptical, narrowed in front to its insertion on the postpetiole. Body, including the antennal scapes and legs covered with short clavate hairs as in the typical *hirticornis*.

Female (ergatoid). Length: 2.8 mm.

Closely resembling the worker, except in the structure of the thorax, which has the female arrangement of the sclerites, but is narrow and shows no traces of having borne wings.

Described from five workers and a single ergatoid female taken by Prof. T. D. A. Cockerell on Flagstaff Mt., near Boulder, Colorado. These are evidently distinct from the typical *hirticornis*, but as I have seen no specimens of this form, I am unable to estimate the precise extent of the differences.

43. **Xiphomyrmex spinosus hispidus** subsp. nov.

Worker. Length: 3.5–3.8 mm.

Differing from the worker of *spinosus* Pergande from the cape region of Lower California, in having the erect hairs on the head and thorax short, stiff and blunt, not longer than those on the gaster, and in the shape of the metasternal angle which is large, flat and rectangular in profile and not in the form of a pointed tooth. The hairs on the legs are coarse and suberect. The epinotal spines are distinctly shorter than their distance apart at the base. The posterior border of the head is distinctly excised and there is a faint transverse dorsal impression between the meso- and epinotum. The postpetiole is less than twice as broad as long and about half again as broad as the petiole, its upper surface is rather finely and vermiculately rugose. Only the anterior half of the first gastric segment is subopaque and finely striolate-shagreened. The antennal funiculi are not infuscated at their tips.

Described from a long series of workers which I found nesting in small craters 3–4 inches in diameter in the deserts around Tucson, Arizona (type locality) and five workers from Phœnix in the same state.

44. **Xiphomyrmex spinosus wheeleri** *Forel.*

Forel described this ant as a distinct species from specimens which I took many years ago in the dry desert at Pacheco, in Zacatecas, Mexico, but a study of three cotypes in my collection shows that it can hardly be more than a subspecies of *spinosus*. As stated by Forel, it differs from *spinosus* in having a distinct mesoëpinotal constriction, in the shape of the metasternal angles which are small and blunt, in the stouter epinotal spines and in having the first gastric segment, except for the scattered piligerous punctures, smooth and shining. The hairs on the legs are oblique, those on the body are pointed, of unequal length, but on the whole decidedly longer than in the preceding subspecies. The clubs of the antennal scapes are infuscated. The head is not more deeply excavated behind than in *hirsutus*, but the upper surface of the petiole is coarsely longitudinally rugose.

I refer two workers which I took in Miller Cañon, Huachuca Mts., Arizona, to this subspecies though their epinotal spines are distinctly smaller and the rugosity of the postpetiole is more irregular than in the Mexican cotypes. The antennal clubs are not infuscated. The Arizona specimens may represent a distinct variety but the material is hardly sufficient to justify the introduction of a new name.

45. **Xiphomyrmex spinosus insons** subsp. nov.

Worker. Length: 3.5–4 mm.

Very similar to the subspecies *wheeleri*, with the epinotal spines long and slightly curved at their tips, the metasternal angles produced into sharp, compressed spines nearly half as long as the epinotal spines, with acute, upturned tips. The postpetiole is twice as broad as long and about $\frac{1}{3}$ as broad again as the petiole, its upper surface coarsely and regularly longitudinally rugose, the gaster smooth and shining, with small, scattered, piligerous punctures. Head very distinctly excised behind; thorax without mesoëpinotal constriction or impression. Erect hairs on the body long and abundant, of unequal length and pointed as in *wheeleri*, those on the legs reclinate. Some specimens show a slight infuscation of the antennal clubs.

Female. Length: 4–4.5 mm.

Closely resembling the worker; pronotum and epinotal declivity transversely, mesonotum, scutellum and pleuræ coarsely, longitudinally rugose. Wings yellowish hyaline, with pale brown veins and darker brown stigma.

Male. Length: 3.5–4 mm.

Head, excluding the mandibles, about as long as broad, with very short cheeks, rounded sides behind the eyes and distinctly excavated posterior border. Mandibles well-developed, with dentate borders. Clypeus convex, with three longitudinal ridges, its anterior border entire. Antennæ 10-jointed; scape as long as the second funicular joint, which is four times as long as the first and longer than joints 3–5 taken together. Thorax rather large, elliptical, broader than the head; mesonotum with distinct Mayrian furrows; epinotum unarmed, feebly convex and steep, without distinct base and declivity. Petiole with a peduncle nearly as long as the rounded node. Postpetiole transverse, about $1\frac{1}{2}$ times as broad as long, rounded above and on the sides. Gaster narrow; legs slender.

Shining; mandibles smooth; head rugose-punctate; thorax and petiole longitudinally rugose, pleuræ and epinotum more opaque, gaster and dorsal surface of petiole smooth and shining.

Hairs yellowish, long and erect, much as in the worker but proportionally longer on the legs.

Black; mandibles and tip of gaster sordid yellow; clypeus, antennæ and legs piceous; tarsi and articulations of legs yellowish. Wings brownish hyaline, with brown veins and stigma.

Described from numerous specimens taken by myself in the following localities:

Texas: Austin (type locality); New Braunfels, Alamito in Brewster County, Alice, San Angelo, Fort Davis, Kenedy, Langtry, Barkdale and Del Rio.

Arizona: Miller Cañon, Huachuca Mts.

This ant nests in small craters in dry, grassy places. There are scarcely more than 70 individuals in a colony. The workers are very timid and forage singly; the winged phases appear during the first week in June.

Subfamily Dolichoderinæ.

46. **Dolichoderus (Hypoclinea) taschenbergi** *Mayr* var. **aterrimus** nom. nov.

This name is suggested for the var. *gagates* Wheeler as Emery had previously described a *Dolichoderus* (*Monacis*) *gagates* from Parà, Brazil.

47. **Bothriomyrmex dimmocki** sp. nov.

Worker. Length: 1.6–1.8 mm.

Closely resembling the Mediterranean *B. meridionalis* but with eyes nearly twice as large and the distance between the eyes and the anterior borders of the head nearly equal to the length of the eyes. The clypeus is proportionally longer and more

convex and slightly sinuate in the middle of its anterior border. Maxillary palpi rather long, 4-jointed as in the European form, but all the funicular joints of the antennæ are distinctly longer than broad. Sculpture of body and pubescence as in *meridionalis* but the color of the head, thorax, coxæ and petiole rather rich brownish red, the gaster dark brown, the mandibles, antennæ and legs dull yellow.

Female. Length: 1.8 mm.

Resembling the worker, except in the structure of the thorax. Eyes scarcely larger than in the worker; ocelli minute. Corners of clypeus distinctly inflated. Mesonotum impressed in the middle behind. Wings hyaline, with pale veins and stigma. The fore wing differs from that of *meridionalis* in lacking the closed discal cell. The color, sculpture and pubescence of the body as in the worker.

Described from two workers, one winged and four deälated females taken by Dr. George Dimmock August 27, 1897, from a single colony on Mt. Tom, near Springfield, Mass.

This insect presents an interesting problem. The seven species of *Bothriomyrmex* hitherto described are all from the Old World, three from the European and African littoral of the Mediterranean, and four from Southern Asia, Java and Australia. The Mediterranean species, as Emery has shown, have 4-jointed, those of Asia and Australia 2-jointed maxillary palpi. The species discovered by Dr. Dimmock agrees with the Mediterranean form in this character but the wings seem to be very different. As nearly as I can make out from the single rather immature specimen of *dimmocki* possessing these organs, the venation is aberrant in lacking the discal cell. This I find to be the case also in a number of male specimens of the Australian *pusillus* Mayr. On receiving the specimens from Dr. Dimmock I doubted the occurrence of a *Bothriomyrmex* in Massachusetts and surmised that there must be some mistake in the label, but he informs me that he certainly took the specimens on Mt. Tom. Then it occurred to me that the form might have been accidentally introduced from abroad, but the species is certainly not one of the seven described forms, six of which I have seen, and the description of *B. walshi* Forel of Bengal, the only one lacking in my collection, does not apply to the Massachusetts specimens. It seems probable therefore that *Bothriomyrmex* is really an indigenous North American genus, but one which is here very rare and on the road to extinction. This conclusion is the more likely since Santschi has shown that the Mediterranean species, at least, are temporary social parasites on *Tapinoma erraticum* after the manner of the species of *Formica* belonging to the *rufa* and *microgyna* groups. The fecundated diminutive queen of *B. meridionalis* and *decapitans* enters the *Tapinoma* nest, and after decapitating the queen of the colony, is adopted by the workers and becomes the mother of the future *Bothriomyrmex* community. We are therefore justified in supposing that *B. dimmocki* behaves in a similar manner towards our

common *Tapinoma sessile*, and if we assume that this ant has almost completely outgrown the toleration of its parasite, we can understand why the latter is so very rare and local that it has never been taken except by Dr. Dimmock.

Subfamily Camponotinæ.

48. **Polyergus lucidus montivagus** subsp. nov.

Worker. Differing from the typical *lucidus* of the Eastern States in the distinctly paler and more yellowish red color of the body, in not having the gaster infuscated at the tip, in the complete or nearly complete absence of erect hairs on the posterior corners of the head, the smaller number of hairs on the gula and the distinctly less shining surface of the head and thorax.

Female. Colored like the worker and not like the female of *lucidus*, which has the head, thorax and petiole of a striking, dark fuscous red tint. The wings, too, are paler with paler veins and stigma and the surface of the body, especially of the head and thorax, is distinctly less glabrous and shining. Gaster decidedly larger and longer than in *lucidus*.

Male. Differing from the male *lucidus* in the paler wings, which are whitish hyaline, with colorless veins and pale brown stigma, whereas in *lucidus* the wings are faintly brownish, with brown veins and blackish stigma. The border of the petiole seems to be somewhat more acute in profile and the whole node more compressed anteroposteriorly and even more deeply excised than in *lucidus*. The legs, antennal funiculi and gaster in many specimens are paler and more reddish.

Described from numerous specimens of all three phases taken from several colonies in the cañons about Colorado City and Manitou, Colorado, The winged phases were taken July 11 to 15 and August 11 to 20. The slaves in all the colonies belonged to a form of *Formica schaufussi* Mayr near the variety *incerta* Emery, without erect hairs on the gula and petiolar border, but like the typical form in other respects, though somewhat smaller. The specimens of *montivagus* have been compared with large series of the true *lucidus* from many localities in the Eastern States and leave no doubt that the two forms represent distinct geographical races.

49. **Polyergus rufescens breviceps** *Emery* var. **umbratus** var. nov.

Worker. Length: 6–5.7 mm.

Differing from the typical *breviceps* of Colorado in its somewhat larger size and decidedly darker color, the whole body and appendages being uniformly rich, reddish brown. The head and mandibles are also smoother and more shining than in most specimens of *breviceps*.

Described from numerous individuals taken from a single colony at Brookdale, California, by Prof. Harold Heath. The slave ant accompanying these specimens belongs to a small variety of *Formica fusca* L. near the var. *argentea* Wheeler.

50. **Polyergus rufescens læviceps** subsp. nov.

Worker. Length: 4–5.5 mm.

Decidedly smaller than the subsp. *breviceps* Emery and of the same size as the subsp. *bicolor* Wasmann, but differing from both in the shorter and more sudden enlargement of the tips of the antennal scapes and in the surface of the body which is much smoother and more shining throughout. The head, especially, is conspicuously glabrous and shining. Pubescence on the thorax and gaster as in *breviceps* and the color is the same, except that the apex of the gaster behind and including the posterior margin of the second segment is black. In many specimens the posterior margin of the first segment is also more or less infuscated.

Described from numerous specimens belonging to two companies of workers which I found making slave raids on the slopes of Mt. Tamalpais, near San Francisco, Cala., July 19, 1914. The ants from whose nest they plundered the brood belonged to *Formica subpolita* Mayr.

51. **Camponotus acutirostris** *Wheeler* var. **clarigaster** var. nov.

Worker Major. Length nearly 12 mm.

Differing from the typical *acutirostris* in having the gaster reddish yellow throughout like the thorax; the antennal scapes and first funicular joint, tibiæ and metatarsal joints black; the mandibles nearly black, the clypeus dark red and the tips of the femora infuscated. From the var. *primipilaris* Wheeler it differs in its smaller size and in lacking the infuscation of the gaster and pronotum.

A single specimen taken at an altitude of about 3000 ft. on the Bright Angel Trail in the Grand Cañon, Arizona. The large number of *acutirostris* specimens which I collected in the Huachuca Mts., Arizona, make it seem possible that this form, and its vars. *primipilaris* and *clarigaster* are merely stature and color varieties of *C. ocreatus* Emery, but till I see unmistakable worker specimens of this ant, I hesitate to regard the specific name *acutirostris* as a synonym.

52. **Camponotus yogi** sp. nov.

Worker Major. Length: 8 mm.

Head rectangular, fully $1\frac{1}{4}$ times as long as broad, with straight, parallel sides and broadly excised posterior border; in profile convex above, obliquely truncated anteriorly and flat below. Eyes rather large, elliptical, well behind the middle of the sides of the head. Mandibles small, thick, wedge-shaped in profile, their outer

borders convex, their apical borders with five subequal teeth. Clypeus flat, entirely ecarinate, $1\frac{1}{2}$ times as long as broad, as broad behind as in front, slightly broader in the middle. Frontal carinæ strongly diverging in front, approximated and parallel behind. Frontal area indistinct. Antennæ slender; scapes curved and slightly flattened at the base, scarcely enlarged at their tips, which reach to the posterior corners of the head. Thorax short, not longer than the head, broadest through the pronotum which is about $\frac{3}{4}$ as broad as the head, narrowed and laterally compressed behind, in profile evenly arcuate above, with strong promesonotal and mesoëpinotal sutures; base and declivity of epinotum distinct, the former slightly convex, shorter than the latter, which is abruptly sloping and distinctly concave. Petiole very much compressed anteroposteriorly, with sharp, broadly rounded and entire superior border, the anterior and posterior surfaces very feebly convex. Gaster narrow, nearly as long as the head and thorax together, with parallel sides. Legs moderately long; fore femora somewhat incrassated.

Head behind the eyes, thorax, petiole, gaster and legs shining, smooth, with very fine, sparse and indistinct punctures. Mandibles slightly shining, coarsely and rather densely striatopunctate; clypeus and anterior half of head opaque, densely punctate and covered with coarse, slightly elongate foveolæ. Front with several round foveolæ; vertex punctate. Antennal scapes slightly shining, finely punctate.

Hairs yellowish, slender, sparse, rather short and erect on the body and upper and posterior portion of the head, shorter on the mandibles, very short and obtuse on the clypeus, and sculptured portions of the head where they arise from the elongate foveolæ. Legs with very short appressed hairs except at the knees where they are longer and erect.

Head, petiole, epinotum, mesonotum, gaster and scapes castaneous; pronotum, funiculi and legs paler and more yellowish red or testaceous.

Worker Minor. Length: 4 mm.

Head small, but little longer than broad, rounded behind, a little broader behind than in front, evenly convex above, not truncated anteriorly. Clypeus subcarinate, nearly as broad as long. Mandibles rather narrow. Antennal scapes reaching fully $\frac{1}{3}$ their length beyond the posterior border of the head. Thorax and petiole shaped much as in the worker major, but the former proportionally higher through the mesonotum. Gaster less elongate, elliptical.

Mandibles finely striatopunctate, glossy; whole head smooth and shining, like the remainder of the body, not sculptured anteriorly.

Hairs white, delicate, sparse and rather short, not modified on the anterior portion of the head.

Color like that of the worker major, except that the scapes as well as the funiculi of the antennæ are colored like the legs and mandibles and the head is also testaceous in front and castaneous only on the vertex and occiput.

Described from single major and minor workers taken by Mr. Percy Leonard from a hollow twig of manzanita near the Raja Yogi Institute on Point Loma, near San Diego, Cala. This species is unlike any of our other North American *Camponoti*. It clearly approaches the species of *Colobopsis* and should, perhaps, be included in that subgenus, though the peculiar truncated anterior portion of the head is not circular nor distinctly marginate as in such forms as *C. truncatus* Spinola, *impressus* Roger, *abditus* Forel and *pylartes* Wheeler.

(*Continued from 4th page of cover.*)

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Proceedings of the American Academy of Arts and Sciences.

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THE AUSTRALIAN HONEY-ANTS OF THE GENUS LEPTOMYRMEX MAYR.

By William Morton Wheeler.

THE AUSTRALIAN HONEY-ANTS OF THE GENUS LEPTOMYRMEX MAYR.[1]

By William Morton Wheeler.

Received, May 6, 1915.

Little study has been devoted, either by the European systematists or the field naturalists of Australia, to the singular ants of the genus *Leptomyrmex*. I have therefore undertaken to record such observations as I was able to make on these fascinating insects during a brief visit to New South Wales and Queensland in the latter part of 1914, and at the same time to summarize what was previously known about them from the scattered sources, in the hope that some of my entomologist friends in Australia may be induced to make a more exhaustive study. The species of *Leptomyrmex*, unlike so many Australian ants, are perfectly harmless and would, no doubt, live well in artificial nests of rather simple construction. The entomologist who could devote a little patient study to these insects under such conditions would unquestionably be rewarded by obtaining answers to some if not to all of the questions suggested in the following pages.

The worker *Leptomyrmex* is easily recognized by the extraordinary attenuation and elongation of all parts of the body, except the abdomen. Curiously enough, both the petiole and the gaster show only a slight tendency to elongation, in marked contrast with the very slender legs and antennæ. Emery [2] regards the genus as constituting by itself one of the four tribes of the subfamily Dolichoderinæ, the principal distinctive characters being the great attenuation of the head, thorax and appendages, the rather soft and flexible integument, the peculiar structure of the proventriculus, the distinct separation of the antennary and clypeal fossæ, and the very aberrant venation of the fore wings of the male.

The proventriculus of *L. erythrocephalus* has been studied by both Forel and Emery. The former figures the organ *in toto*, the latter

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1 Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 89.

2 Genera Insectorum, Fasc. **137**, 15 et seq. (1912).

figures a series of transverse sections through its anterior and posterior portion. The accompanying sketches (Figs. 1 and 2) represent the organ in *L. nigriventris* and *unicolor*. In both species it is hard and of a glassy texture, as Emery observed, and its four valves (v.) are large, with rounded, lobe-like, anterior ends. Their inner surfaces appear to be very hairy, especially along the edges. The bulbous, posterior portion (b.) of the organ is large and rather sharply marked off from the valvular and cylindrical regions (c.). The muscular layer (m.), which seems not to have been seen by Emery, is well-developed,

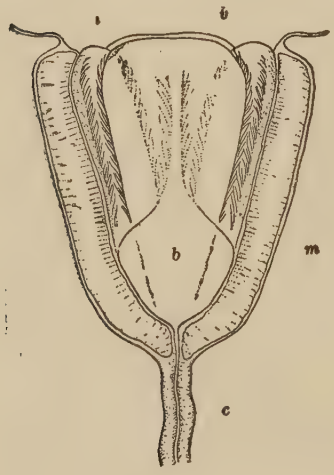

Fig. 1

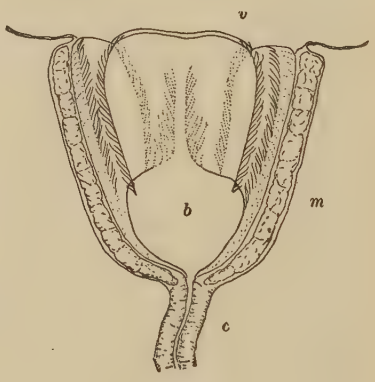

Fig. 2

FIGURE 1. Proventriculus of *Leptomyrmex nigriventris*, *i.* wall of crop, *v.* valve, *m.* muscles, *b.* bulb, *c.* cylindrical portion.

FIGURE 2. Preventriculus of *Leptomyrmex unicolor*. *v.* valve, *m.* muscles, *b.* bulb, *c.* cylindrical portion.

especially in *nigriventris*. In *unicolor* this layer is much feebler and the whole organ is shorter and smaller.

No other Dolichoderine ant has a proventriculus of the same type as that of *Leptomyrmex*, though in *Dolichoderus* it is somewhat similar. Since the proventriculus functions as a valve between the ingluvies, or crop and the ventriculus, or true stomach, its very high development in the species of *Leptomyrmex*, as shown by the large size of the chitinous valves and the thick layer of musculature enveloping them, is evidently correlated with the habit in these insects of storing large quantities of liquid food in the crop. This is also indicated by the

fact that in *L. unicolor,* which is probably the only species that does not have this habit, the organ is much smaller, the valves proportionally shorter and the layer of musculature much thinner.

The venation of the fore wing in the male *Leptomyrmex,* too, is unlike that of any known ant (Fig. 3). The pterostigma is reduced to a mere vestige. The radial vein is well developed and with the costa encloses a long, narrow radial cell. The cubitus comes off from the radius and describes a curve, terminating near the tip of the wing. The media is well developed, its terminal portion describing a curve similar to that of the cubitus. There is no cubital or discal cell. The short transverse vein running from the pterostigma to the media is divided into two portions, the anterior of which is regarded by Emery as the base of the radius, the longer, posterior portion as representing a fusion of a transverse cubital with the recurrent nervure. He

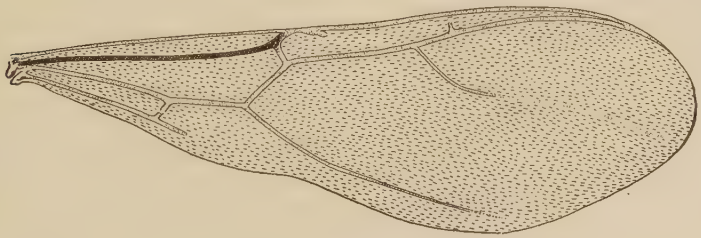

FIGURE 3. Wing of male *Leptomyrmex* sp. from Cooktown, Northern Queensland.

believes, therefore, that the basalis, which is a fundamental cross-vein in the Hymenopteran wing, is completely lacking in *Leptomyrmex.* In support of this view he calls attention to a male ant from the Sicilian amber (Miocene), which he formerly called *Leptomyrmex maravignæ,* but for which he has recently established a new genus, *Leptomyrmula.* This insect is more primitive than *Leptomyrmex* in having a vestige of the basalis arising from the media and in possessing a developed pterostigma.

Another peculiarity of the genus *Leptomyrmex,* to which attention has not been called heretofore, is the absence of a queen, or female caste in any of the known species. At any rate, no one has ever seen a female *Leptomyrmex.* I shall return to this subject in the sequel.

Very few observations have been recorded on the habits of any of the species. Gilbert Turner has published a note on *L. erythrocepha-*

lus which he observed at Mackay, Queensland.[3] He noticed the peculiar position in which the gaster is carried by the foraging worker and discovered that "certain workers in every nest have their abdomen greatly distended by a sweet transparent fluid. These workers are only found at the bottom of the nest, about two feet from the surface; they can move about, but are not as active as the unaltered workers and never leave the nest." Forel [4] says that Turner found this replete condition of the gaster in *L. varians* Emery var. *rufipes* Emery at Mackay. Perhaps this form was erroneously cited as *L. erythrocephalus* in Turner's paper. The only other note I have seen on the habits of Australian *Leptomyrmex* is the following sentence in Lowne's paper [5] referring to *L. erythrocephalus:* "I never saw but one specimen of this remarkable insect alive; it was running upon the ground in the bush; it frequently took a leap of nearly three inches; it does not run so fast as its form would lead one to suppose." As I have seen many *Leptomyrmex* running about and have never seen any of them jump, I am sure that Lowne's statement is erroneous. He must have mistaken some jumping *Myrmecia*, probably *nigrocincta* F. Smith, for a *Leptomyrmex.*

I have found the nests and observed something of the behavior of the following species and varieties of *Leptomyrmex: erythrocephalus, nigriventris, unicolor* and the varieties *rufipes* and *ruficeps* of *varians.* All of these ants, and also the other species of which I have seen only single workers or specimens taken by other collectors (*L. froggatti, wiburdi* and var. *pictus* and *L. varians* var. *rothneyi*) live in the woods and never in open, cleared country. *L. unicolor* is confined to the shady rain-forests ("scrub") of northern Queensland, *L. varians* var. *ruficeps* occupies similar stations in the same region, the var. *rothneyi* and *rufipes* prefer the open *Eucalyptus* forests of the dryer portions of Queensland and *nigriventris, wiburdi* and *erythrocephalus* inhabit similar situations in New South Wales, especially in the Triassic sandstone region of the Blue Mountains.

The nests are either in the ground or in great rotten logs, and although one may readily locate them by carefully following foraging workers, one is often disappointed to find them in situations where they cannot be excavated. When in the ground the nest is usually

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3 Notes upon the Formicidæ of Mackay, Queensland, Proc. Linn. Soc. N. S. W., **22**, 1897, 129–144 (1898).

4 Fourmis Nouvelles d'Australie. Rev. Suisse Zool. **10**, 473 (1902).

5 Contributions to the Natural History of Australian Ants. The Entomologist, **2**, 278 (1865).

under the large roots of some tree, and when in a log, it is nearly always in the very heart. The entrance is large, often an inch or more in diameter, and leads into a gallery varying from a foot and a half to two feet in length. This gallery is frequently broader than the entrance and both in logs and in the ground terminates in a large chamber sometimes 3–5 inches in diameter. In no case did I see the ants excavating, nor did I find any pellets of earth or wood surrounding the entrance of the nest. From this negative observation, the large size of the nest cavities and the very slender and frail stature of the ants, I infer that they do not excavate nests, but simply take possession of cavities that have been made and later abandoned by lizards or small marsupials (phalangers).

Unlike other Dolichoderine ants the *Leptomyrmex* workers forage singly and never in files. They are, in fact, endowed with great initiative and appear to be far and away the most intelligent of the Dolichoderinæ. Their ordinary gait as they move about on their long legs is stately and elegant, but may be greatly accelerated if they are frightened. The appearance of these ants is peculiar owing to the gaster being bent forward over the thorax. In *L. unicolor* the gaster is thrown so far forward that its dorsal surface is applied to the dorsal surface of the thorax as shown in Fig. 12. In the other species the retroflexion is less pronounced, the gaster being carried nearly at a right angle with the thorax or inclined slightly forward (Figs. 5 and 6). While walking or running with the gaster in this position, the insects resemble diminutive motor-cars, so that they have been called by some of the Australians "motor-car ants." The long thorax certainly resembles the body, or tonneau, the turned up gaster the canopy, and in such forms as *erythrocephalus* and *ruficeps* the red head suggests the large head-light of a motor car.

Usually the ants are seen running along or across roads through the woods. They forage mostly on the ground, but do not hesitate to climb trees and shrubs. They are all highly carnivorous. I have seen them capturing and carrying home a great variety of insects (flies, beetles, moths) and even earthworms. The prey is taken into the nest and there dismembered so that its juices can be more readily imbibed. I doubt whether these ants ever attend honey-dew-producing scale-insects or other Homoptera.

In all the colonies which I examined, except those of *L. unicolor*, I found a certain percentage of repletes, i. e. individuals having the gaster so greatly distended with a perfectly colorless liquid, that it was quite spherical, with its intersegmental membrane tensely ex-

panded and separating the dark dorsal and ventral sclerites from one another. *L. unicolor* evidently has not developed this honey-storing habit. In all the other species the individuals which become repletes must begin their development in this direction as soon as they hatch from the pupæ and before their integument has hardened. In several nests I found a certain number of callows that had already become perfect repletes. The repletes of *Leptomyrmex* are not helpless like those of the American *Myrmecocystus mexicanus* and *melliger* and their varieties, but run about easily though not so rapidly as the ordinary workers. They are, however, much more interested in the brood than the ordinary workers. As soon as the nest is disturbed every replete grabs a larva or pupa and makes off with it. If possible they all retire to the ceiling of the innermost nest chamber and there huddle side by side, each quietly holding its larva or pupa in its jaws. Though the ordinary workers occasionally carry away some of the brood, they are conspicuously less interested in this occupation than their replete sisters. Turner states that these individuals do not leave the nest, but on two occasions at Kuranda, Queensland, I found repletes of *L. varians* var. *ruficeps* returning to their nests along a road through the scrub.

Numerous larvæ and in most cases pupæ were found in the nests during October and November, but all the pupæ collected proved to be workers and I saw no males in any of the nests. Moreover, the most careful scrutiny failed to reveal the presence of anything like a queen or female in any of the nests and on several occasions I must have captured the entire colony. Nor was it possible to detect among the workers any individual or individuals that showed signs of functioning as queens of the colony. If winged queens existed they would certainly have been taken by this time, for these ants are rather abundant in many localities in New South Wales and Queensland. I believe, in fact, that no true queens occur in the genus *Leptomyrmex*, but that there are in each colony one or more fertile workers which supply the eggs that develop into workers and males. We have here one of the interesting problems to be solved by the resident Australian entomologist. In this connection I may state that some other Australian ant-genera are peculiar in lacking queens, notably *Rhitidoponera* and *Diacamma*. In still another series of Ponerine genera (*Onychomyrmex*, *Paranomopone* and *Leptogenys*) the queens are wingless and extremely worker-like.

The *Leptomyrmex* larva is very peculiar. That of *L. nigriventris* is shown in Fig. 4a. The head (b) is violin-shaped, with very small,

pointed, vestigial mandibles, showing that the food of the larva is purely liquid and imbibed directly from the regurgitating workers. The sensory papillæ on the maxillæ and labium are well-developed. The body shows three well-marked thoracic and five or six abdominal segments. It is covered with extremely short hairs. The larva of *L. varians* var. *ruficeps* is similar, but the skin is entirely naked. The larva of *L. unicolor* has a short, rounded head (Fig. 4c), much like that of other ant larvæ, though the mandibles are very feebly developed. The body is covered with hairs which are somewhat sparser and stiffer than in *nigriventris*.

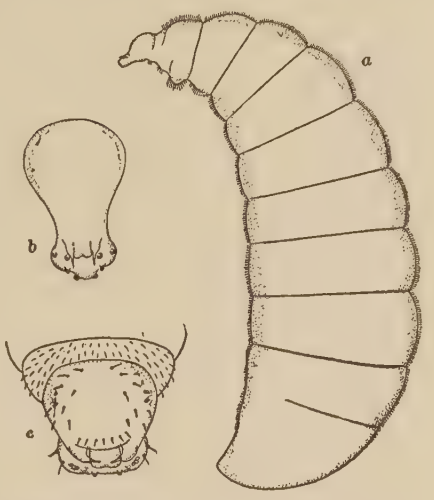

FIGURE 4. *a*. Larva of *Leptomyrmex nigriventris*, *b*. head of same from above, *c*. head of larva of *L. unicolor*.

On disturbing the colonies I found that the ants seldom attacked me with their mandibles, but usually hurried about over my hands, face and clothing like a lot of long-legged spiders, filling the air with the rank, rancid butter, or "*Tapinoma*" odor so characteristic of most species of Dolichoderinæ. This excretion is discharged as a liquid from the anal glands and is so sticky that my skin felt as if it had been varnished. This was especially noticeable after opening nests of *L. varians* var. *ruficeps*. *L. unicolor*, however, emits a more delicate and pleasant modification of the *Tapinoma* odor and the liquid is not discharged in sufficient quantity to make the skin perceptibly sticky. Additional notes on habits are given in connection with the taxonomic descriptions of each of the species and varieties in the latter part of this paper.

I found no myrmecophiles in the nests which I examined, but the following brief notes show that the species of *Leptomyrmex*, like other ants, have their Arthropod guests, enemies and mimics. October 19 on a footpath near Katoomba, N. S. W., I picked up a specimen of

L. erythrocephalus which had a small Dipteran puparium firmly glued to the dorsal surface of its thorax. This puparium had its long axis parallel with that of the ant's body and its anterior end directed toward the ant's head. Unfortunately the fly had already escaped. I am inclined to believe that it must have been one of the Phoridæ. Turner [6] calls attention to a "spider that takes to itself the appearance of a worker of *Leptomyrmex erythrocephalus* Fabr. and curves its abdomen upwards and forwards until it rests on the top of the thorax, exactly the same as the ant," and Rainbow [7] mentions a Misumenine spider which feeds exclusively on *L. erythrocephalus*.

The geographical distribution of the species of *Leptomyrmex* is very suggestive. Of the eight recorded species five (*erythrocephalus*, *nigriventris*, *froggatti*, *varians* and *unicolor*) are confined to Australia, and, so far as known, to the eastern or littoral portion of New South Wales and Queensland, one (*fragilis*) occurs in the Aru Islands and New Guinea, one (*niger*) in New Guinea only, and one (*pallens*) in New Guinea and New Caledonia.[8] Of the Australian species, the typical *nigriventris* and *froggatti* seem to be confined to New South Wales, *varians* and its varieties to Queensland, while *erythrocephalus* ranges over both states. *L. unicolor* is restricted to the Cape York Peninsula of Northern Queensland.

The occurrence of the genus *Leptomyrmula* in the Sicilian amber shows that the tribe *Leptomyrmicii* had once a very wide distribution in the Old World and that the present restriction of the genus *Leptomyrmex* to Papua and Australia is the results of the complete extinction of probably many genera and species of the tribe over the greater part of its former range. The question then presents itself: Did the species of *Leptomyrmex*, like so many of the animals and plants of Eastern Queensland and New South Wales, originate in New Guinea and migrate into Australia, or is it an indigenous Australian genus, which, like some of the Eucalypti, Epacrideæ and phyllodineous Acacias among plants, has spread to New Guinea and New Caledonia? The larger size of the species and their greater number in Australia certainly indicate that this is the center of distribution, but which ever

6 loco citato, p. 136.

7 Descriptions of Some New Araneidæ of New South Wales. No. 8. Proc. Linn. Soc. N. S. W., **22**, 514–533, 2 pls. 1897 (1898).

8 Stitz's recent record of *L. erythrocephalus* from "Newcastle, New Zealand", (Australische Ameisen, Sitzb. Gesell. Naturf. Freunde, Berlin, 1911, p. 368) is evidently a blunder, which Emery has unfortunately cited in the Genera Insectorum as indicating a possible importation of this ant into New Zealand. Newcastle is a flourishing town in New South Wales.

view we take, we are bound to assume that the genus could only have reached its present distribution at a time when land connections existed between New Guinea, Australia and New Caledonia, if I am right in maintaining that winged females do not occur in the genus.

There are, however, still other considerations that point to the origin of the genus *Leptomyrmex* in Australia and the subsequent migration of some of its species to Papua, viz. the development of the honey-storing habit in the different species. I have found repletes in all the Australian species except *unicolor*. *L. pallens* of New Caledonia is known to have repletes, and the same is probably true of *niger* and *fragilis*, although nothing is known concerning the habits of these two Papuan forms. I regard *L. unicolor* as the most primitive species of the genus, because its larva is least modified, because the adult has not acquired the honey-storing habit and because it is confined to the moist coastal "scrub." Nearly all the other forms live in much dryer situations and have evidently developed repletes as a means of tiding over the dry season. We know that this habit has been independently developed in several other Australian ant genera. It has long been known in *Melophorus* species and in a *Camponotus* (*C. inflatus*). I have observed it in several species of *Pheidole* and in an undescribed *Pheidologeton* from Queensland, a genus not hitherto recorded from Australia. In the species of these two genera the soldiers have become repletes, with a very noticeable though not spherical distension of the gaster. Now the Australian botanists have concluded from the differences between the juvenile and adult foliage of the Eucalypti and phyllodineous Acacias that the Australian climate was originally much more humid than it is at the present time. The honey-ants point to the same conclusion, and in *Leptomyrmex* we still find one species, *unicolor* which preserves the ancient habits of the genus and lives only in the coastal rain-forests, while all the other forms have become modified for storing liquid food during protracted periods of heat and drought.

Like most other Dolichoderinæ the species of *Leptomyrmex* are poor in plastic characters. As Emery has shown, they are most easily distinguished by the shape of the head, though some of them present useful characters in the shape of the thorax, petiole, gaster and tibiæ. Sculpture and pilosity are very monotonous throughout the genus. According to my observations, there is very little variation in color among the members of a colony, but several and perhaps all of the species exhibit one or more color varieties. These sometimes form a series from pale to dark forms which may be repeated in another spe-

cies. Thus the typical *erythrocephalus* resembles *varians* var. *ruficeps*, *erythrocephalus* var. *cnemidatus* and *nigriventris* var. *tibialis* resemble *varians* var. *rufipes*, *froggatti* is much like *varians* var. *rothneyi*, etc. Probably many color varieties remain to be discovered in parts of Queensland and New South Wales hitherto unvisited by the entomological collector. The following table may serve for the identification of the workers of the known species and varieties:

1. Head, excluding mandibles, short, less than twice as long as broad; gaster slender, at least three times as long as broad; eyes hairy. . . . . *unicolor* Emery.
   Head longer and narrower; gaster much broader; eyes naked. . 2.
2. Gaster rufotestaceous, at most with a brown spot on the sides *fragilis* F. Smith.
   Gaster, with at least the two basal segments black. . . . . 3.
3. Tibiæ distinctly compressed or flattened. . . . . 4.
   Tibiæ not or very slightly flattened. . . . . 12.
4. At least the head rufotestaceous. . . . . 5.
   Head deep blackish brown. . . . . *froggatti* Forel.
5. Ventral surface of petiole strongly convex, smaller species (7–8 mm.). . . . . 6.
   Ventral surface of petiole feebly convex or flattened, somewhat larger species (8–10 mm.). . . . . 7.
6. Thorax black, only the sutures red. . . . . *wiburdi* sp. nov.
   Thorax red, with black dorsal spots. . . . . var. *pictus* var. nov.
7. Head narrow, contracted behind. . . . . 8.
   Head shorter, broadly rounded behind. . . . . 11.
8. Thorax black. . . . . 9.
   Thorax rufotestaceous. . . . . 10.
9. Mandibles, clypeus and antennal scapes red. *erythrocephalus* Fabr.
   Mandibles, clypeus and antennal scapes black. var. *mandibularis* var. nov.
10. Femora black; tips of antennal scapes brown. var. *decipiens* var. nov.
    Tips of femora black; scapes red throughout. var. *cnemidatus* var. nov.
11. Legs rufotestaceous throughout. . . . . *nigriventris* Guérin.
    Tibiæ and tips of femora black, the former more compressed. var. *tibialis* Emery.
12. Head elongate behind and constricted at the occiput. Length 8.5–10 mm. . . . . 13.

Head narrowed behind but not constricted at the occiput. Length 6–8 mm.....16.

13. Thorax entirely or very largely rufotestaceous.....14.
Thorax entirely or largely black or dark brown.....15.

14. Pronotum and sometimes also the mesonotum with a black spot. *varians* Emery.
Thorax entirely rufotestaceous.....var. *rufipes* Emery.

15. Head rufotestaceous.....var. *ruficeps* Emery.
At least the posterior portion of the head black. var. *rothneyi* Forel.

16. Head, thorax and gaster brownish black.....*niger* Emery.
Head or thorax, or both rufotestaceous.....17.

17. Head, thorax, petiole and legs rufotestaceous, gaster dark brown or black.....*pallens* Emery.
Of a different color.....18.

18. Head, excepting the mandibles, black; legs rufotestaceous. var. *nigriceps* Emery.
First two gastric segments black, remainder red, distal halves of femora blackish.....var. *geniculatus* Emery.

1. **Leptomyrmex erythrocephalus** (Fabricius).

(Fig. 5a and b.)

Formica erythrocephala Fabricius, Syst. Ent. 1775, p. 391 ☿ ; Spec. Insect, 1, 1781, p. 488 ☿ ; Mant. Insect. 1, 1787, p. 307 ☿ ; Gmelin. Linné, Syst. Nat. Ed. 13ª 1, 1790, p. 2797; Olivier, Encycl. Méthod. Insect. 6, 1791, p. 491; Fabricius, Syst. Ent. 2, 1793, p. 351; Latreille, Hist. Nat. Fourmis 1802, p. 277 ☿ ; Lowne, Entomologist 2, 1865, p. 278.

Atta erythrocephala Fabricius, Syst. Piez. 1804, p. 423 ☿ .

Formica ? erythrocephala F. Smith, Catalog. Hymen. Brit. Mus. 6, 1858, p. 37 ☿ .

Leptomyrmex erythrocephalus Mayr, Verh. zool. bot. Ges. Wien, 12, 1862, p. 696 ☿ ; Journ. Mus. Godeffroy 12, 1876, p. 77 ☿ (in part); Forel, Bull. Soc. Vaud. Sc. Nat. (2) 15, 1878, Pl. 23, Fig. 9; Emery, Bull. Soc. Ent. Ital. 15, 1883, p. 147, ♀ Fig. 3; Ann. Mus. Civ. Stor. Nat. Genova (2) 4, 1887, p. 252; Dalla Torre, Catalog. Hymen. 7, 1893 p. 162; Emery, Ann. Soc. Ent. Belg. 39, 1895, p. 351 ☿ ; Froggatt, Agric. Gaz. N. S. W., Sept. 1905, p. 23; Stitz, Sitzb. Ges. Naturf.

Freunde Berlin, 1911, p. 368 ♀ ; Emery, Genera Insect. Fasc. 137, 1912, p. 16, Pl. 1, Fig. 4.

Leptomyrmex erythrocephalus? Emery, Mem. Accad. Sci. Bologna, (5) 1, 1891, p. 578 ♂, Pl. 2, Fig. 23.

Worker. Length 9–10 mm.

Head, excluding the mandibles, twice as long as broad, with the eyes half way between its posterior border and the anterior border of

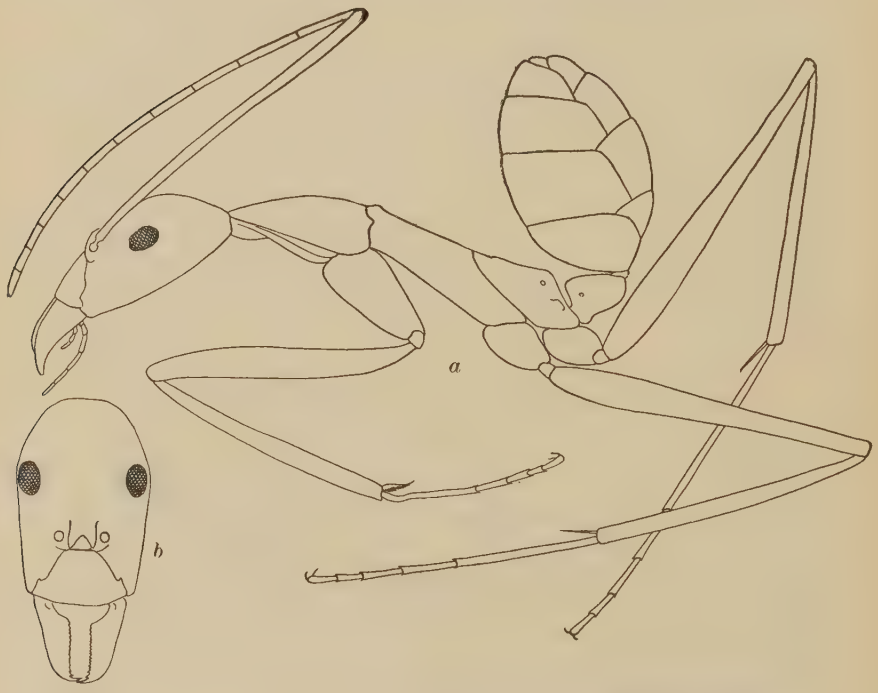

FIGURE 5. *a. Leptomyrmex erythrocephalus* Fabricius. Worker with gaster in position in which it is usually carried; *b.* head of same from above.

the cheeks, its sides straight and parallel in front of the eyes, behind them suddenly narrowing but slightly convex to the short, very feebly excised occipital border. Mandibles rather long, with about 20 small, crowded and irregular teeth on the apical and several more indistinct teeth on the basal border. Clypeus bluntly carinate behind, its anterior border feebly emarginate or nearly straight in the middle. Antennæ slender, scapes surpassing the head by about $\frac{3}{5}$ of their length.

Thorax long and slender, pronotum longer than the mesonotum, which is longer than the epinotum; epinotal declivity only about $\frac{1}{3}$ as long as the base. Petiole small, its node blunt, with a feeble longitudinal impression on its summit, its anterior surface somewhat angulate near the base in profile, straight above and shorter than the straight, sloping posterior surface; ventral surface feebly convex behind. Gaster elliptical in non-replete individuals. Femora and tibiæ distinctly compressed.

Whole body, including the mandibles, subopaque, very finely and densely shagreened; mandibles with a row of coarse punctures along the apical margin.

Whole surface appearing pruinose, because covered with extremely fine, short, whitish pubescence. Hairs confined to mandibles and clypeus, where they are very short and mostly yellowish, and to the venter, where they are much longer and black. Flexor surfaces of tibiæ with an irregular row of short black bristles.

Black, with faint bluish or greenish reflections; head, antennæ, tarsi, trochanters, knees and tips of tibiæ rufotestaceous; palpi black.

New South Wales: Blue Mts. (Beccari and E. D'Albertis); Sydney (Lowne, L. M. D'Albertis); Katoomba, Blue Mts. (Wheeler); Jenolan Caves, Blue Mts. (J. C. Wiburd); Mittagong (W. W. Froggatt).

Queensland: Rockhampton (Froggatt); Peak Downs (Museum Godeffroy); Mackay (G. Turner).

This is the type of the genus. I have seen no specimens from Queensland, and suspect that some of the records, like that of Turner, may refer to *L. varians* var. *ruficeps*, which, owing to the great similarity in color, is very easily mistaken for *erythrocephalus*.

In his work on the ants of the Sicilian amber (1891) Emery describes and figures from some Queensland specimens what he takes to be the male of this species. A male received from Staudinger and Bang-Haas, from Cooktown on the Cape York peninsula, agrees with Emery's description but I hesitate to regard either it or the specimens described by Emery as males of *erythrocephalus*, because there are at least two other species in northern Queensland (*varians* and *unicolor*) to either of which they may be assigned with equal probability.

One small nest of *L. erythrocephalus*, which I found in the Kanimbla Valley, near Katoomba, was in the ground under the edge of a boulder. The gallery from the entrance descended only about four inches into the soil and there enlarged into a chamber about five inches long, three inches broad and an inch high. This contained about 60 workers with larvæ. Only six of the workers were in the replete condition.

2. **Leptomyrmex erythrocephalus** var. **mandibularis** var. nov.

Worker. Differing from the typical form in sculpture and color. The thorax, petiole, gaster, femora and tibiæ seem to be of a deeper black, because the pubescence is more scanty. The mandibles, clypeus, except its posterior border, frontal carinæ and antennal scapes are black; the anterior portion of the cheeks and a broad median streak on the gula are fuscous, the funiculi brown with reddish tips, the tarsi brown, the hind metatarsi somewhat darker. The surface of the body and head is distinctly smoother and more shining than in the typical form.

Described from a single specimen sent me many years ago by Mr. H. Ashton from the vicinity of Sydney, New South Wales.

3. **Leptomyrmex erythrocephalus** var. **decipiens** var. nov.

Worker. Length 7–8 mm.

Differing from the typical form and the foregoing variety in its smaller size and peculiar coloration. The head, thorax, petiole, coxæ, trochanters, knees, tibial spurs and tarsi are rufotestaceous, the gaster black, the femora and tibiæ dark brown, the tips of the antennal scapes more or less infuscated.

Described from nine specimens taken at Gin-Gin, Queensland and sent me many years ago by Mr. W. W. Froggatt. This variety, which at first sight may be easily mistaken for a form of *varians* or even more readily for *nigriventris* var. *tibialis*, is here referred to *erythrocephalus*, because the head has precisely the same shape and the femora and tibiæ are flattened as in that species, whereas the tibiæ are more slender and terete in *varians* and the head is more slender and conical behind. On the other hand, the head of *tibialis*, judging from Emery's description, seems to be even broader than in the typical *nigriventris*.

4. **Leptomyrmex erythrocephalus** var. **cnemidatus** var. nov.

Worker. Length 9 mm.

Differing from the var. *decipiens* only in the coloration of the legs and antennæ, the latter being rufotestaceous throughout, like the head, thorax and petiole, while the dark brown of the former is confined to

the tibiæ and the apical third or fourth of the femora. The black gaster has very pronounced metallic blue reflections.

A single specimen obtained several years ago from Staudinger and Bang-Haas. It is from New South Wales and was erroneously labelled "*L. rufipes* Emery."

5. **Leptomyrmex froggatti** Forel.

Forel, Rev. Suisse Zool. 18, 1910, p. 57 ♀ ♂; Froggatt, Agric. Gaz. N. S. W., Sept. 1905, p. 23; Emery, Genera Insect. Fasc. 137, 1912, p. 17.

"*Worker.* Length 8–9 mm.

"Mandibles a little shorter than in *erythrocephalus*, densely punctate and shagreened, subopaque, their terminal borders armed with 19 to 20 very distinct, crowded teeth. Clypeus impressed in front in the middle, straight behind its anterior border. Head as in the typical *erythrocephalus*, with the sides convex behind the eyes, much less narrowed than in *varians* Emery and its varieties, about twice as long as its anterior diameter. Eyes situated much further back than in *erythrocephalus*, towards the third fifth of the head. Antennæ a little shorter than in *erythrocephalus*, form of thorax similar, but somewhat less elongate. Petiole with a strong convexity below. It is more elongate behind the node, which is lower, not so thick, with its posterior surface more oblique and an antero-superior surface which is much shorter and a little more clearly marked off from a subtruncate antero-inferior surface. The legs are shorter.

"Deep blackish brown. Scapes, femora and petiole paler brown. Funiculi, border of mandibles, tarsi, sometimes the tibiæ, and in general the posterior third of the epinotum, the coxæ, bases of the femora and the lower portion of the thorax with the lower portions of its sides behind, testaceous. This color is almost the same as that of *varians* var. *rothneyi* Forel, but the latter has the head much narrowed behind and the legs and antennæ are much longer.

"*Male.* Length 7.7 to 8 mm.

"Mandibles elongate triangular, with obtuse tips. Scape shorter than the three first funicular joints together. Head like that of the worker, but narrower in front than behind the eyes. Pronotum forming a narrow and flat neck in front, to which the anterior convexity of the metanotum descends vertically; but the posterior raised third of the dorsum of the pronotum forms the lower portion of this sub-

vertical wall. Epinotum elongate; its basal subhorizontal face has posteriorly a large transverse impression. Declivity rather short, a little convex, very oblique, with two elevated stigmata above on the sides. Petiole without a distinct node, only more convex above than below. External genital valves with the form of an obtuse equilateral triangle (in *pallens* Emery, they have a long, narrow, curved appendage). On the other hand, one of the rami of the median valves is prolonged into a narrow style forked like a Y, the inferior branch of which is sharp and pointed like a needle.

"Sculpture, pilosity and pubescence as in the worker.

"Gaster nearly black; thorax, mandibles, femora and tibiæ brown. Declivity of epinotum, petiole and the remainder of body, including the head, yellowish testaceous. Wings brown, pubescent, having only the scapular and externo-median cells; all the others lacking; the nervures, however, without the appearance of atrophy.

"Certain workers are almost entirely black, like *unicolor* Emery, but this latter has a much broader and shorter head, which is concave behind, and the petiolar node is longer and lower; the epinotum is also shorter and more convex (with the appearance of a concavity on the basal surface as in the worker *froggatti*). *L. froggatti* is also allied to *niger* Emery, but this species has no teeth on the terminal border of the mandibles,[9] the head is much narrower behind and the petiole and epinotum have a different form. Finally, *nigriventris* Emery, (*recte* Guérin) has a broader head and higher node.

"New South Wales (Walcher), in wood."

I have not seen this species and have therefore translated Forel's description. It is cited by Froggatt from Noundoc, N. S. W.

6. **Leptomyrmex nigriventris** (Guérin).

(Fig. 6a and b.)

Formica nigriventris Guérin, Duperry, Voyage de Coquille, Zool. 2, 1830, p. 203, ♀ Pl. 8, Fig. 4;

Leptomyrmex nigriventris Emery, Ann. Mus. Stor. Nat. Genova, 24, 1887, p. 252 ♀ ; Dalla Torre, Catalog. Hymen. 7, 1893, p. 162 ♀ ; Ann. Soc. Ent. Belg. 39, 1895, p. 351 ♀ , fig.; Froggatt, Agric. Gaz. N. S. W.,

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9 This statement is clearly contradicted by Emery's figure, which I have reproduced on p. 275.

Sept. 1905, p. 23; Emery, Genera Insect. Fasc. 137, 1912, p. 17; Stitz, Sitzber. Ges. Naturf. Freunde Berlin, 1912, p. 507 ♀.

Worker. Length: 9–12 mm.

Head, excluding the mandibles, less than twice as long as broad, rather robust, broadest just behind the eyes, the lateral borders in front of the eyes straight and slightly concave, behind the eyes convex and but slightly narrowed at the occipital border, which is broad and straight when the head is seen squarely from above. Eyes rather small, situated half way between the anterior border of the cheeks

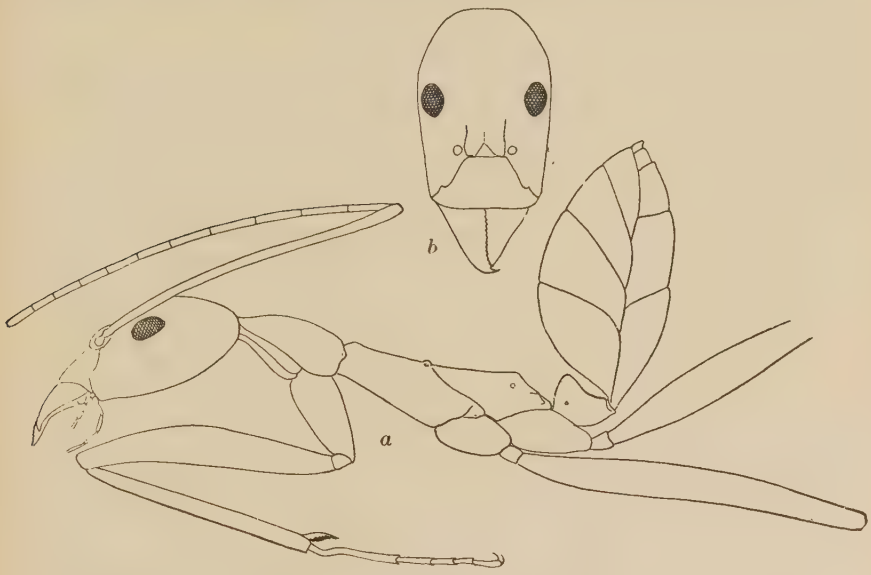

FIGURE 6. *a. Leptomyrmex nigriventris* Guérin, worker, with gaster in position in which it is usually carried; *b.* head of same from above.

and the posterior border of the head. Apical border of mandibles with about 20 crowded, irregular denticles. Anterior clypeal border impressed in the middle. Antennal scapes extending only a little over half their length beyond the posterior border of the head. Pronotum rather robust, only $1\frac{1}{2}$ times as long as broad. Base of epinotum somewhat concave in profile. Petiolar node rather high, its summit and anterior surface convex and rounded, with a distinct median longitudinal impression; posterior surface longer, concave. Gaster rather broad, elliptical. Femora and tibiæ distinctly compressed.

Subopaque, very finely and densely shagreened; mandibles slightly shining, coarsely punctate along the apical margin.

Pubescence extremely short and fine, less distinct than in *erythrocephalus*, covering the body and appendages. Hairs as in *erythrocephalus*.

Rufotestaceous throughout, except the gaster which is black, with bluish or greenish reflections.

New South Wales: Blue Mts. (Beccari and E. D'Albertis); Mt. Victoria (L. M. D'Albertis); Leura and Katoomba, Blue Mts. (Wheeler).

New Guinea: (Bürgers).

This is the largest of the species of *Leptomyrmex*. September 20 I found a fine colony in a large rotten *Eucalyptus* log near Katoomba. The nest cavity was in the center of the log and about five inches in diameter. It contained about 200 workers and many pure white larvæ. About one in six of the workers was in the replete condition. Each of these repletes, when the nest was disturbed, seized a larva and stalked out of the nest, and did not quicken its pace unless touched. A few workers on the road in a different locality near Katoomba were seen dragging an earthworm two and one half inches long to their nest.

The citation of this ant from New Guinea by Stitz seems to me to be very doubtful.

7. **Leptomyrmex nigriventris** var. **tibialis** Emery.

Emery, Ann. Soc. Ent. Belg. 39, 1895, p. 39 ♀ ; Genera Insect. Fasc. 137, 1912, p. 17; Froggatt, Agric. Gaz. N. S. W. Sept. 1905, p. 23.

Worker. Length 9–11.

Differing from the typical form in having the tibiæ more strongly compressed; and with both these and the tips of the femora black. The tint of the testaceous portions of the body is deeper. The head is a little broader in the largest individuals.

Northern Queensland (Podenzana).

8. **Leptomyrmex wiburdi** sp. nov.

(Fig. 7a and b).

Worker. Length 6.5–8 mm.

Resembling *erythrocephalus*, but smaller, and the head, excluding the mandibles, less than twice as long as broad. Cheeks distinctly con-

cave; head broadest just behind the eyes and more rounded behind than in *erythrocephalus* and *nigriventris*. Eyes large, as long as half their distance from the anterior border of the cheeks, situated a little more than half way from this border to the posterior border of the head. Anterior border of clypeus impressed in the middle. Mandibles rather slender, with about 20 crowded denticles on the apical border. Antennal scapes surpassing the head by less than $\frac{2}{3}$ their length. Thorax and petiole shaped much as in *nigriventris*, but the lower surface of the latter much more convex and the impression on the summit of the node very faint. Tibiæ distinctly compressed.

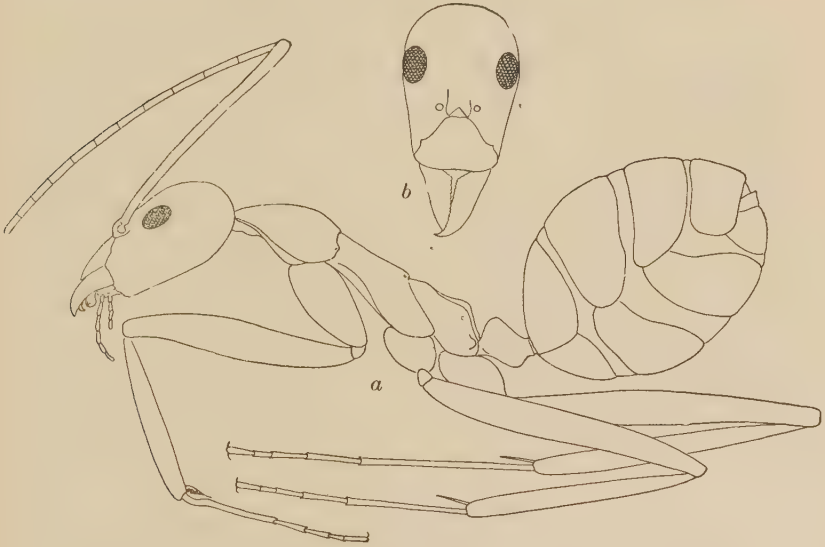

FIGURE 7. *a. Leptomyrmex wiburdi* sp. nov. Worker, nearly replete; *b.* head of same from above.

Subopaque, very finely and densely shagreened; mandibles slightly shining, coarsely punctate along the apical border.

Hairs very few, confined to mandibles, clypeus and venter. Pubescence extremely fine, giving the body a pruinose appearance, most distinct on the thorax and gaster.

Black, with bluish reflections; head, antennæ, trochanters, knees, tarsi and articulations of thorax yellowish testaceous; femora and tibiæ blackish brown, the latter often paler than the former. Palpi and a faint cloud on the vertex of the head fuscous.

Described from numerous specimens taken by Mr. J. C. Wiburd at

the Jenolan Caves in the Blue Mts. of New South Wales. The series comprises a number of repletes and larvæ showing that Mr. Wiburd took the colony from the nest. A single worker taken by myself in the Bulli Pass, New South Wales, agrees very closely with the types. It is difficult to decide whether *wiburdi* is a distinct species or merely an extreme variety or subspecies of *nigriventris*. For the present I prefer to regard it as a species characterized by small size, large eyes and the shape of the head, especially the concavity of the cheeks.

9. **Leptomyrmex wiburdi** var. **pictus** var. nov.

Worker. Length 7–8 mm.

Differing from the typical form in color, the thorax being yellowish red or testaceous, like the head, with a large black spot on the pronotum, a small one on the mesonotum and in some specimens also a still smaller or more indistinct one on the epinotum. The legs are red, with the apical $\frac{3}{4}$ of the femora black and all except the base and tip of the tibiæ dark brown or blackish. In some specimens the black spots on the dorsum of the thorax are more extensive and almost confluent and the outer surfaces of the coxæ are blackish or infuscated. Such specimens constitute transitions to the typical form.

Described from five specimens taken by myself in the Bulli Pass, New South Wales and a single one taken at Katoomba in the same state. The nest of this variety was not discovered and only specimens running about singly on the foot-paths were seen.

10. **Leptomyrmex niger** Emery.

(Fig. 8.)

Emery, Termesz. Füzet. 23, 1900, p. 333, Pl. 8, Fig. 43 ♀ ; Stitz, Stitzb. Ges. Naturf. Freunde Berlin, 1911, p. 367 ♀ ; Viehmeyer, Abhandl. Ber. k. zool. u. anthr. ethnogr. Mus. Dresden 14, 1912, p. 22, ♀ ; Emery, Genera Insect. Fasc. 137, 1912, p. 17.

Worker. Length 8 mm.

Head elongate, more than twice as long as broad, with slightly convex cheeks; posterior to the eyes, which are situated behind the middle of the sides, the sides are arcuately narrowed. Antennal scapes very slender, compressed. Petiole with a low rounded node, the an-

terior and posterior surfaces forming nearly a right angle with each other in profile.

Color brownish black; mandibles, funiculi and tips of tibiæ fusco-testaceous; tarsi pale yellow.

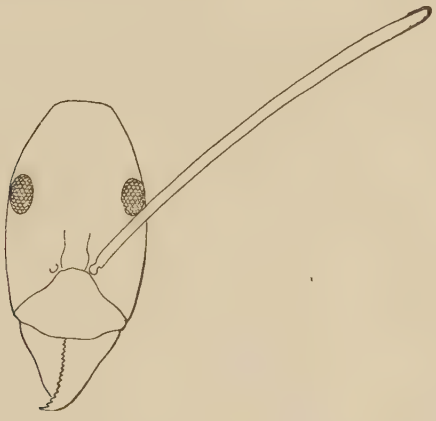

FIGURE 8. *Leptomyrmex niger* Emery. Head of worker after Emery.

German New Guinea: (L. Biró), Huongolf (Neuhaus).

As I have not seen this species I have translated and rearranged Emery's original description and reproduced his figure. The shape of the head is very characteristic and easily separates the species from *unicolor* which it closely resembles in color.

11. **Leptomyrmex fragilis** (F. Smith).

(Fig. 9.)

Formica fragilis F. Smith, Journ. Proc. Linn. Soc. Zool. 3, 1858, p. 136, ♀.

Leptomyrmex fragilis Emery, Ann. Mus. Stor. Nat. Genova, 38, 1897, p. 571, Pl. 1, Figs. 17 and 18, ♀ ♂; Viehmeyer, Abhand. ber. k. zool. anthr. ethnogr. Mus. Dresden 14, 1912, p. 22, ♀; Emery, Genera Insect. Fasc. 137, 1912, p. 15; Stitz, Sitzb. Ges. Naturf. Freunde, Berlin, 1912, p. 507, ♀ ♂.

"*Worker.* Length 6.5–7 mm.

"Head narrowed behind the eyes in the form of a cone and somewhat constricted at the occiput, where it is very narrow, a conformation which is more pronounced in this species than in *L. varians* Emery.

"Uniformly pale testaceous, often with an elongate brown spot on each side of the gaster.

"*Male.* Length 7–8 mm.

"Head rhomboidal, elongate, narrowed anteriorly and posteriorly. Mandibles linear, toothless, truncated at the tip. Pronotum bigibbous, with a median sulcus. Petiole growing broader posteriorly, twice as long as broad. Posterior femora and tibiæ flexuous. In the genital armature the stipes is simple and hairy, the volsella long, curved like a hook; between the stipes and volsella there projects a straight styliform lacinia, provided with a small, smooth appendage. In the fore wing the outer branch of the cubital is detached from its trunk.

FIGURE 9. *Leptomyrmex fragilis* F. Smith. Head of worker after Emery.

"Yellowish testaceous; mandibles, antennæ, femora and tibiæ brown in some specimens; tarsi very pale. Wings smoky, with brown veins."

Aru Islands (A. R. Wallace).

British New Guinea: Moroka, Bujakori, Haveri, Paumomu River (L. Loria).

Ceram (Tauern).

I have here translated Emery's brief description and reproduced his figure of the head of the worker. This phase was rather vaguely described by Smith. Emery's figure shows that the species is closely related to *pallens* and *varians*. It may, however, be readily distinguished by the more constricted occiput and the pale color of the gaster, which in all the other known species is largely or entirely black or very dark brown.

12. **Leptomyrmex pallens** Emery.

(Fig. 10.)

Emery, Bull. Soc. Ent. Ital. 15, 1883, p. 147, ♀ Fig.; Ern. André, Rev. d'Ent. 6, 1887, p. 290 ♂; Froggatt, Agric. Gaz. N. S. W. Sept. 1905, p. 23; Stitz, Sitzb. Ges. Naturf. Freunde Berlin, 1911, p. 368 ♂;

ibid. 1912, p. 507 ♀ ; Emery, Genera Insect. Fasc. 137, 1912, p. 17; Viehmeyer, Abhand. Ber. zool. anthr. ethnogr. Mus. Dresden, 14, 1912, p. 22 ♀ ; Emery, in Sarasin and Roux, Nova Caledonia, 1, 1914, p. 418.

Worker. Length 6–7.5 mm.

Head, excluding the mandibles fully twice as long as broad; in front of the eyes with straight, subparallel sides, behind the eyes conical and narrowing rapidly but without constriction to the short, straight, occipital border. Antennæ very slender, the scapes surpassing the head by about ¾ their length. Thorax slender; pronotum nearly twice as long as broad; epinotum rather short, its base feebly convex and only twice as long as the declivity. Petiole small, its anterior and posterior surfaces rather straight, its blunt summit very feebly impressed in the middle. Gaster broadly elliptical; legs very slender; tibiæ not compressed.

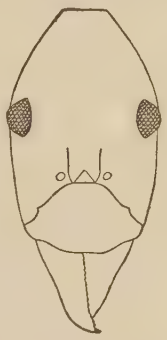

FIGURE 10. *Leptomyrmex pallens* Emery. Head of worker.

Surface of body slightly shining, very finely and densely shagreened. Mandibles with a single row of coarse punctures along the apical border.

Hairs very feebly developed as in the other species; pubescence white, extremely fine, so that the surface is scarcely pruinose.

Pale rufotestaceous; gaster brownish black.

Male. Length 7 mm.

Rufotestaceous throughout, except the black eyes and the ocellar orbits and articulations of the wings which are brownish black. Body slightly shining, extremely finely and superficially shagreened. Pubescence and pilosity almost absent. Wings slightly smoky, with brownish veins.

New Caledonia: Oubatche, Yambé, Hienghiéne, Coné, Canale, Valley of the Négropo, Coindé, La Foa, Valley of Ngoi, Yaté, Nouméa (Sarasin and Roux).

Loyalty Islands: Ouvea, Fayaoué (Sarasin and Roux).

German New Guinea (Lauterbach).

Dutch New Guinea: Tana (Moszkowski).

This species, of which I have examined two worker specimens received from Professors Emery and Forel, is very similar to *L. varians* but is smaller and the head is less elongated and not constricted at the occiput. The description of the male is taken from Ern. André.

13. **Leptomyrmex pallens** var. **geniculatus** Emery.

Emery, in Sarasin and Roux, Nova Caledonia, Zool. 1, 1914, p. 418, ♀.

Worker. Differing from the typical form in color, the body being pale rufotestaceous, except the two first segments of the gaster and the distal halves of the femora, which are black.

New Caledonia: Tchalabel, Coula-Borearé (Sarasin and Roux).

I have examined a cotype of this variety kindly sent me by Prof. Emery.

14. **Leptomyrmex pallens** var. **nigriceps** Emery.

Emery, in Sarasin and Roux, Nova Caledonia, Zool. 1, 1914, p. 418, ♀.

Worker. Head, except the mandibles, and the whole gaster black; remainder of body and appendages rufotestaceous.

New Caledonia: La Madelaine (Sarasin and Roux).

Emery states that this variety makes its nests under stones and that Roux found "individuals having the gaster distended with a transparent liquid," in other words, repletes.

15. **Leptomyrmex varians** Emery.

L. varians Emery, Ann. Soc. Ent. Belg. 39, 1895, p. 351, 352, ♀ Fig.; Froggatt, Agric. Gaz. N. S. W., Sept., 1905, p. 23; Emery, Genera Insect. Fasc. 137, 1912, p. 17.

L. erythrocephalus Mayr (in part.) Journ. Mus. Godeffroy, 12, 1876, p. 77.

Worker. Length 8.5–10 mm.

Head, excluding the mandibles, fully twice as long as broad; the sides in front of the eyes nearly straight and parallel, behind the eyes rapidly contracting to the narrow straight occipital margin, just in front of which on each side, the border is concave. Eyes rather small and convex, half way between the anterior border of the cheeks and the occipital border. Antennæ very slender, scapes terete, extending somewhat less than $\frac{2}{3}$ their length beyond the posterior border of the head. Pronotum slightly more than $1\frac{1}{2}$ times as long as broad. Epinotum in profile with concave base, about twice as long as the

very convex declivity. Petiole triangular in profile with straight anterior and posterior surfaces meeting at somewhat less than a right angle; summit of node with a distinct longitudinal impression. Gaster elliptical, rather narrow. Legs very slender, tibiæ not compressed.

Subopaque, very finely shagreened; mandibles with a row of coarse punctures along their apical border.

Hairs on mandibles and clypeus very feebly developed, longer, coarser and black on the venter; pubescence whitish, extremely short and fine.

Head, thorax and antennæ, rufotestaceous; gaster, pronotum, and in some specimens a spot on the mesonotum black; legs black; tarsi fulvous.

Queensland: Rockhampton (Museum Godeffroy);

This species is very closely related to *pallens* but differs in its greater size and the more elongate and posteriorly constricted head. I have not seen specimens of the typical form but of the following varieties:

16. **Leptomyrmex varians** var. **rufipes** Emery.

Emery, Ann. Soc. Ent. Belg. 39, 1895, p. 352, ♀ ; Forel, Rev. Suisse Zool. 10, 1902, p. 473, ♀ (replete); Froggatt, Agric. Gaz. N. S. W. Sept. 1905, p. 23; Emery, Genera Insect. Fasc. 137, 1912, p. 17; Boll. Lab. Zool. Gen. e Agrar. R. Scuola Sup. d'Agric. Portici 8, 1914, p. 180.

Worker. Differing from the typical form of the species in color. The gaster and distal halves of the femora are black; the remainder of the body, including the anus and a spot at the base of the first gastric segment rufotestaceous.

Queensland: Laidely, Brisbane (Podenzana); Mackay (G. Turner); Darra, Toowong and Botanical Garden, Brisbane (Wheeler).

New South Wales: Gosford (F. Silvestri).

According to Forel, Gilbert Turner discovered the repletes of this variety at Mackay. I found two nests, both in the ground in dry woods, one at Toowong, and the other at Darra, but was unfortunately unable to excavate them. The one at Toowong was under the root of a large tree in very hard, stony soil, that at Darra under a large log in which an extremely irritable colony of wasps (*Icaria socialistica*) was nesting. When the log was turned over these insects compelled Mr. Henry Hacker and myself to beat a hasty retreat.

17. **Leptomyrmex varians** var. **ruficeps** Emery.

(Fig. 11).

Emery Ann. Soc. Ent. Belg. 39, 1895, p. 352 ♀ ; Froggatt, Agric. Gaz. N. S. W. Sept. 1905, p. 23; Emery, Genera Insect. Fasc. 137, 1912, p. 17; Boll. Lab. Zool. Gen. e Agrar. R. Scuola Sup. d'Agric. Portici 8, 1914, p. 180.

Worker. Differing from the typical form and preceding variety in color. The head and antennæ are yellowish testaceous; the thorax, gaster and femora black; the tibiæ, tarsi and anal orifice pale yellow.

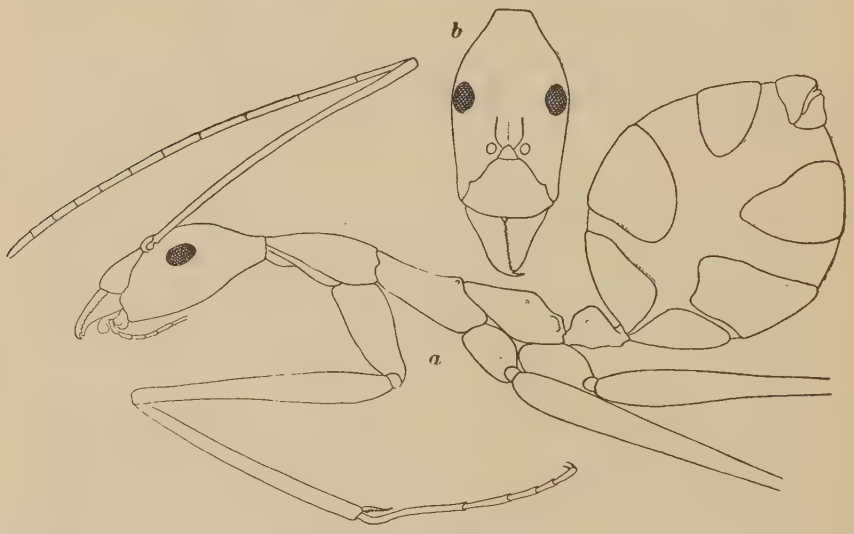

FIGURE 11. *Leptomyrmex varians* Emery, var. *ruficeps* Emery, replete worker; *b*. head of same from above.

Queensland: Mt. Bellenden Ker (Podenzana); Cairns (Froggatt); Kuranda (Wheeler).

New South Wales: Katoomba, Blue Mts. (F. Silvestri).

I found this variety to be very common in the vicinity of Kuranda, where it may be seen stalking about singly on almost any of the shady paths in the tropical "scrub." The following notes on three nests which I examined may be of interest in connection with the remarks on behavior in the introduction to this paper:

October 19 I found a nest in a hollow log nearly 50 feet long that was lying in the shade. The ants were entering the log by a large opening. On breaking into it, I found that the cavity extended through the more decomposed, central wood to such a distance that I could introduce my whole arm into it. The colony comprised about 200–300 workers, only the ordinary forms of which rushed out of the nest when it was first broken open. The numerous repletes took refuge at the blind end of the cavity where they hung from the ceiling. On thrusting my tweezers among them, many came out, each carrying a larva or pupa. Later both repletes and many of the ordinary workers found that they could go deeper into the log where I could not reach them. I estimated one replete to about 25 or 30 of the ordinary workers. On returning to this nest a few hours later I found that nearly all the ants had gone back to their nest and that only a few were outside the entrance looking through the débris for lost larvæ and pupæ.

On October 24 two other colonies of *ruficeps* were found in the same locality. One of them was in the center of a large rotten log, which the ants entered at one end by an opening fully eight inches across. The cavity ran back a distance of fully two feet, preserving this same diameter. When the nest was disturbed most of the ants retreated to the blind end of the cavity where I could reach them only with a stick. When this was thrust among them, numerous repletes, each carrying a larva or pupa in its jaws, came to the entrance.

The second nest was a more fortunate discovery. On accidentally kicking off the upper half of a large and very rotten log for a distance of about two feet, I found that I had opened a large *ruficeps* nest. The ants were mostly on the ceiling of a large cavity and comprised fully 300 ordinary workers and at least 50 repletes, every one of which was holding a larva or pupa in its jaws.

I observed that *ruficeps* workers, on the approach of evening, often carry each other back to the nest. I have not noticed this habit in other Dolichoderinæ, though it is common in many Myrmicinæ and Camponotinæ. On several occasions *ruficeps* was seen carrying caterpillars and dead ants to its nest. The repletes, as stated on p. 260 occasionally leave the nest.

18. **Leptomyrmex varians** var. **rothneyi** Forel.

Forel Rev. Suisse Zool. 10, 1902, p. 473 ♀ ; Froggatt, Agric. Gaz. N. S. W. Sept. 1905, p. 23; Emery, Genera Insect. Fasc. 137, 1912, p. 17.

Worker. Length 11 mm.

Head a little broader at the level of the eyes than in front; contracted behind in the form of a cone, which is narrower and quite as long as in the typical *varians* and the preceding varieties. Antennal scapes surpassing the head by about $\frac{2}{3}$ their length. Gaster brown; head and thorax presenting a mixture of pale brown and yellowish red; femora pale brown; tarsi and tibiæ pale yellow; antennæ yellowish red.

Queensland: Brisbane (Rothney).

I refer to this variety, of which I have translated Forel's description, a single specimen found running on the ground in dry woods at Enoggera, near Brisbane, Queensland. The mandibles, cheeks and mouthparts, the pleuræ and whole epinotum, except a large spot on its dorsal surface, the anal segment, antennæ, tibiæ and tarsi are yellowish testaceous, the remainder of the body brown, the gaster more blackish.

19. **Leptomyrmex unicolor** Emery.

(Fig. 12.)

Emery, Ann. Soc. Ent. Belg. 39, 1895, p. 351, 352, ♀ Fig. ; Froggatt, Agric. Gaz. N. S. W., Sept. 1905, p. 23; Emery, Genera Insect. Fasc. 137, 1912, p. 17.

Worker. Length 7–8.5 mm.

Head, excluding the mandibles, not more than $1\frac{1}{2}$ times as long as broad, broadest at the level of the eyes, convex in the frontal region, flattened beneath; sides behind the eyes rather straight and converging to the broad, straight occipital border. Eyes about half way between the anterior borders of the cheeks and the posterior border of the head. Mandibles moderately long, with about 20 small, crowded teeth on the apical and several distinct teeth on the basal border. Antennal scapes slender, distinctly flattened, surpassing the head by nearly $\frac{3}{5}$ their length. Thorax rather short, pronotum less than $1\frac{1}{2}$ times as long as broad; base and declivity of epinotum subequal, passing into each other through a very rounded angle. Petiole narrow, with a low, rounded node, with subequal anterior and posterior slopes, the former feebly convex, the latter straight in profile, the ventral surface only feebly convex. Gaster slender, more than three times as long as broad. Legs slender; tibiæ very slightly flattened.

Subopaque very finely and densely shagreened; mandibles smooth and shining along their apical borders and at the tips, with a few coarse punctures.

In addition to the pilosity on the clypeus, mandibles and venter, there are also prominent black hairs on the coxæ, and the scapes and legs are covered with abundant, minute, oblique black hairs. Eyes distinctly hairy.

Body, femora and tibiæ black, with bluish or greenish reflections; antennal scapes black, with their apical third or fourth brown; mandibles and labium brownish yellow, the former with a fuscous spot or

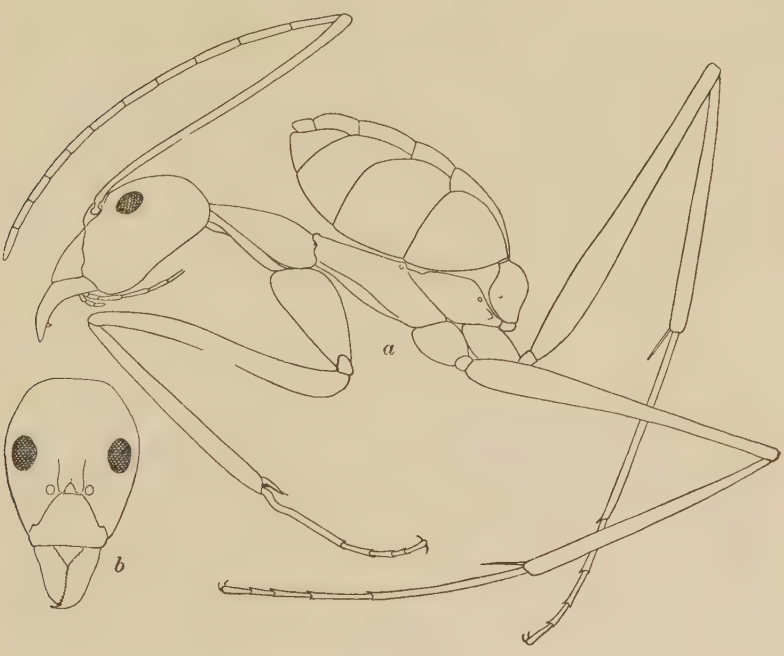

FIGURE 12. *a. Leptomyrmex unicolor* Emery, worker, with gaster in the position in which it is usually carried; *b.* head of same from above.

cloud at the base on the external margin; metatarsi of all the feet white; remaining tarsal joints, tibial spurs and the antennal funiculi fulvous.

Queensland: Cairns (Podenzana); Kuranda (Wheeler).

This species is very easily recognized, as it differs from all the others in the shape of the head and gaster, in color and pilosity, the position in which the gaster is carried during life, the structure of the larval

head, etc. Though less abundant than *varians* var. *ruficeps* at Kuranda, it is nevertheless very common in that locality, where it is confined to the shady tropical scrub. The nests, however, are not easily found. October 21 I followed a worker *unicolor*, that was carrying a small white moth, for a distance of nearly 50 feet along a dark path in the scrub, till the nest was located as a large hole under the roots of a great fig tree. These prevented excavation, but I was able to run a stick into the cavity for a distance of 18 inches, when many of the repletes poured out, indicating that I had penetrated to the end of the nest. October 28 I discovered two nests which were accessible in red rotten logs. The first contained only 50 workers, but many young larvæ. The other colony occupied a large cavity fully two feet long and several inches broad in the heart of the log. This colony comprised fully 250 or 300 workers, with numerous larvæ and pupæ, apparently all of the worker phase. In both these nests the larvæ and pupæ were on the floor of the cavity till the ants were disturbed, when they seized them in their jaws and huddled together on the ceiling. In none of the nests of this species were there any repletes.

Postscript.

Since the foregoing account of the species of *Leptomyrmex* was sent to the press, Forel has published an important contribution to our knowledge of the Australian ant-fauna (Results of Dr. E. Mjöberg's Swedish Scientific Expeditions to Australia 1910–1913, 2. Ameisen, Arkiv för Zool. 9, 1915, pp. 1–119, 3 pls., 6 text-figs.), containing descriptions of a new species and new variety of *Leptomyrmex* and of the hitherto unknown male of *L. varians* var. *ruficeps*. For the sake of completeness, I include a translation of these descriptions:

Leptomyrmex varians Emery var. ruficeps Emery.

"*Male.* Length 7.5–7.7 mm.

Entirely pale reddish yellow; wings feebly suffused with yellow and with brownish yellow veins. The narrow head is contracted anteriorly and posteriorly and nearly $2\frac{1}{2}$ times longer than broad in the middle. The large convex eyes lie in the middle and occupy nearly $\frac{1}{3}$ of the whole head. Antennal scape shorter than the long second funicular joint. First funicular joint as broad as long. The

mesonotum in front nearly overarches the pronotum, from which it is separated by a deep constriction. The whole thorax is cylindrical. The declivous surface of the epinotum is not half as long as the basal surface; the two stigmata form a sharp angle between the two surfaces. Surface lustrous and pubescent, without erect hairs except on the venter."

Leptomyrmex erythrocephalus var. rufithorax Forel.

"*Worker.* Length 9–10.7 mm.

Entirely like the type of the species, but with the whole thorax red and not only the head. Legs, petiole and gaster brownish black."

Queensland; Mt. Tambourine (E. Mjöberg).

Leptomyrmex mjöbergi Forel.

"*Worker.* Length 5.3–6 mm.

Head fully twice as long as broad. Clypeus ecarinate, with nearly straight anterior border (scarcely convex, without a lobe). The eyes are feebly convex and lie somewhat behind the middle of the sides of the head. Behind them the head is distinctly but gradually narrowed, and with convex lateral margins and has behind a narrow but distinct occipital border, which is rather concave than convex (much as in *erythrocephalus*). The antennal scape surpasses the occipital border by $\frac{3}{5}$ of its length. Thorax between the base of the epinotum and the promesonotum distinctly constricted. The promesonotum is very feebly but uniformly convex, distinctly lower than the basal surface of the epinotum, and this surface is twice as long as the declivity. The petiole is rather strongly inclined forward, nearly twice as high as long and has about the form of an anteriorly inclined parallelopipedon, which is, however, somewhat convex above and with flat, but anteriorly inclined anterior and posterior surface.

Surface of body moderately shining, throughout finely and superficially shagreened, with delicate, short and sparse pubescence and without erect hairs.

Black; femora, scapes and tibiæ brown; mandibles reddish brown; tarsi reddish yellow.

Queensland; Colosseum, Tolga, Herberton (E. Mjöberg).

This, the smallest species of the genus, with its entirely black body

and relatively high, thin petiole, is totally different from the other known species."

The following forms were also taken by Mjöberg in Queensland:

L. varians Emery var. *rothneyi* Forel ♀ — Blackal Range.

L. varians Emery var. *rufipes* Emery ♀ — Blackal Range.

L. varians Emery var. *ruficeps* Emery ♀ — Glen Lamington, Logan Village, Atherton, Malanda, Cedar Creek, Herberton. Forel, on the authority of Mjöberg, says that this species is called the "sugar ant" by the Australian colonists. This is an error, as the "sugar ant" is *Camponotus nigriceps* F. Smith.

L. nigriventris Guérin var. *tibialis* Emery. ♀ — Mt. Tambourine.

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(Continued on page 2 of Cover.)

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SYSTEMATIC PAPERS ON NEW ENGLAND HEMIPTERA

By H. M. PARSHLEY

[Reprinted from Psyche, Vol. XXII, No. 3]

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SYSTEMATIC PAPERS ON NEW ENGLAND HEMIPTERA.[1]

By H. M. Parshley.

With Plates VI and VII.

I. Synopsis of the Families.

The tables to be published under the above title form a part of a general account of the Hemiptera [2] of New England on which I am engaged, but as an early appearance of the whole is not to be expected, it seems desirable that the more generally useful parts be made immediately available.

There are to be found in various publications a number of keys to the families of Hemiptera, but for one reason or another they do not enable those who are unfamiliar with the group to place specimens with certainty in their proper families. Some are inaccurate, some incomplete, while those which are free from these faults are very difficult to work because they generally lack figures and employ obscure characters, the latter often necessary in a table which aims at universality or natural arrangement. It seems to me that these difficulties can be avoided by limiting the application of the key to the fauna of a restricted region,[3] sacrificing natural arrangement in favor of clearness, and illustrating structures of importance. The synopses in this series are offered as an attempt in that direction.

In preparing the tables I have made free use of the writings of previous authors, but all the work has been done with continual reference to the specimens themselves, more particularly of the species occurring in New England, of which I have before me a fairly complete collection. Thus the characters proposed by others

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 91.

[2] Considered as an order distinct from the Homoptera.

[3] Thus permitting in some cases the use of easily observable characters not common to all members of the family in question.

have been examined with regard to their applicability to our species, and not a few have been found to be decidedly misleading when presented without qualification. Groups not known to me to occur in this region are marked with an asterisk, and those of which I have not as yet seen specimens are indicated by a dagger. I hope that anyone who may know of New England records for the forms so marked will communicate with me on the subject.

The characters which are of distinctive importance are given first in the dichotomies. Those which follow have been added to assist in determination, and they are not necessarily peculiar to the group in question, except such as are strictly alternative. To the short descriptions of the families should be added the characters already used in the appropriate divisions of the key. In studying the smaller forms a binocular or ordinary compound microscope will be found almost indispensable.[1]

There is difference of opinion among authorities regarding the names which should be used for certain families, and in such cases I have given both terms. The cause of this disagreement lies in the fact that the present rules of nomenclature may be interpreted in more than one way. There seems to be a growing sentiment among zoölogists in favor of establishing a list of names not subject to change, and if this action is taken by the International Congress it may be that those of the more familiar names which are now held by some to be invalid will regain their standing.[2]

DESCRIPTIVE SYNOPSIS OF THE FAMILIES.[3]

1. Antennæ shorter than the head, generally concealed in cavities between head and thorax; metasternal orifices absent.....2
   Antennæ as long as or longer than the head, exposed.....8
2. Ocelli present; littoral; not over 10 mm. in length.....3
   Ocelli absent; aquatic.....4

[1] Definitions of a number of hemipterological terms will be found in a paper on the squash-bug by Tower, Ann. Ent. Soc. Am., VI., 1913, p. 427; and in my paper on Miridæ, Ent News, XXVI., 1915, p. 208. In connection with the latter should be mentioned an additional reference on the Mirid "anal" vein; Reuter, Bemerk., Oef. Fin. Vet. Soc. Förh., LIV., 1911–12, p. 19.

[2] It should be noted that as a result of more or less recent nomenclatorial changes, the species represented by certain figures on the plates would be otherwise named by some authorities, as follows: fig. 1, *C. lintneriana;* fig. 3, *Saldula pallipes;* fig. 8, *Hebrus burmeisteri;* fig. 11, *Nabis pallescens;* fig. 13, *Phymata erosa wolffi;* fig. 22, same as fig. 8.

I am indebted to Mr. E. P. Van Duzee for his kindness in giving me advance information in regard to his list of Hemiptera, which is soon to be published.

[3] This table is adapted for the determination of adults only; and mature forms which are brachypterous or wingless must in some cases be treated with caution.

3. Antennæ exposed; front legs similar to intermediate; rostrum 4-segmented, first segment short; front and intermediate tarsi 1-segmented (?), hind 2-segmented; predatory ..... OCHTERIDÆ

   Antennæ concealed; front legs raptorial; rostrum short, 4-segmented; front and intermediate tarsi 1-segmented, hind 2-segmented; eyes very protuberant; short, stout, roughened forms; predatory
   *MONONYCHIDÆ or NERTHRIDÆ

4. Hind tarsi without two distinct claws (except *Plea* which is less than 3 mm. in length); front legs not raptorial in structure; moderate or small in size..5

   Hind tarsi with claws; front legs raptorial.....6

5. Head overlapping thorax dorsally; body flattened above; rostrum short, hidden under a broad flat transversely striated plate (epistoma); front tarsi- 1-segmented, palæform (fig. 28); male genitalia asymmetrical; predatory; swim with dorsal side uppermost..... CORIXIDÆ

   Head inserted in thorax; body convex above; rostrum free, 3- or 4-segmented; tarsi 2-segmented (front tarsi of the male sometimes 1-segmented); predatory; swim with ventral side uppermost..... NOTONECTIDÆ

6. Membrane reticulately veined; large in size.....7

   Membrane without veins; rostrum 3-segmented; front tarsi 1-segmented, intermediate and hind 2-segmented; hind legs not natatorial; predatory; moderate in size ..... NAUCORIDÆ

7. Apical appendages of abdomen long and slender, not retractile; hind legs not much flattened; rostrum 3-segmented; tarsi 1-segmented; hind coxæ rotatory; predatory ..... NEPIDÆ

   Apical appendages of abdomen short and flat, retractile; hind legs distinctly flattened, natatorial; rostrum 3-segmented; tarsi 2-segmented; hind coxæ hinged; predatory ..... BELOSTOMATIDÆ

8. Head shorter than thorax including scutellum.....9

   Head as long as entire thorax, both elongated; ocelli absent; eyes distant from anterior margin of thorax; rostrum 3-segmented; tarsi 3-segmented; body and appendages slender; generally wingless; predatory; aquatic, living on the surface near shore; length about 10 mm..... HYDROMETRIDÆ

9. Claws of at least the front tarsi distinctly anteapical with terminal tarsal segment more or less cleft (fig. 12); aquatic, living on the surface 10

   Claws all apical, last tarsal segment entire; aquatic and terrestrial forms...11

10. Hind femora extending much beyond apex of abdomen; intermediate and hind pairs of legs approximated, very distant from front pair; ocelli present, but sometimes very obscure; eyes close to anterior margin of prothorax (fig. 29); rostrum 4-segmented, first and second segments short (fig. 29); tarsi 2-segmented; parts of hemielytra more or less confluent (fig. 16); often wingless; predatory; moderate in size..... GERRIDÆ

    Hind femora not extending much beyond apex of abdomen; intermediate pair of legs about equidistant from front and hind pairs (except in *Rhagovelia*); ocelli obsolete or absent; rostrum 3-segmented; front tarsi 1- or 2-segmented, intermediate and hind 2- or 3-segmented; predatory; usually live on surface, but some species can dive; moderate or minute in size..... VELIIDÆ

11. Antennæ 5-segmented 12
Antennæ 4-segmented, disregarding minute ring-segments; (antenniferous tubercles of head should not be mistaken for segments, figs. 11, 30) 13
12. First and second segments of antennæ thicker than the others (fig. 8); clavus similar in texture to the membrane which is without veins (fig. 22); head and thorax sulcate beneath; rostrum 3-segmented; tarsi 2-segmented; aquatic, living on the surface; minute in size ..... HEBRIDÆ or NÆOGEIDÆ
First segment of the antennæ thickened, second slender (fig. 1); margin of head carinate above insertion of antennæ; scutellum rather large, usually extending beyond middle of abdomen; terrestrial; moderate in size, rarely minute 32
13. Prosternum with a median longitudinal transversely striated or granulated stridulatory groove visible anterior to front coxæ, receiving the tip of the rostrum; rostrum 3-segmented, short and strong; length not less than 5 mm. 14
Prosternum without a stridulatory groove; size large or small 15
14. Terminal segment of antennæ thickened; front legs highly modified, stout, raptorial (fig. 13); scutellum moderate in size; membrane with numerous veins; front tarsi small and retractile; tarsi 2-segmented; roughly sculptured predatory forms; moderate in size PHYMATIDÆ or MACROCEPHALIDÆ
Terminal segment of antennæ filiform (sometimes faintly divided into numerous small parts); front legs usually much like the others, though raptorial in function, sometimes somewhat thickened and spinous; scutellum small; membrane with few veins; tarsi 3-segmented; body robust or linear; usually predatory; large or small in size ..... REDUVIIDÆ
15. Hemielytra closely reticulate in relief, membranous between the reticulations, more or less lace-like in appearance (figs. 17, 18); size small 16
Hemielytra not so reticulate, or absent; size large or small 17
16. Juga free, produced before apex of head, longer than tylus (fig. 14); hemielytra with a non-reticulate membrane, the rest reticulately punctate (fig. 18); ocelli present; rostrum 4-segmented; tarsi 2-segmented; one small species PIESMIDÆ
Juga not prominent, not longer than the tylus (fig. 15), head sometimes with dorsal anteriorly projecting spines; hemielytra of similar texture throughout, densely reticulate (fig. 17), membranous between the reticulations; ocelli absent; rostrum 4-segmented; tarsi 2-segmented; numerous small species TINGITIDÆ
17. Pronotum divided into three lobes; head contracted behind the eyes; hemielytra wholly membranous, with a few distinct longitudinal and cross veins; ocelli present; rostrum 3- or 4-segmented (?); front tarsi 1-segmented, intermediate and hind 2-segmented; predatory; fly in swarms; very minute and delicate forms[1] ..... *HENICOCEPHALIDÆ
Pronotum, head, and hemielytra otherwise constructed 18
18. Rostrum really or apparently 3-segmented 19
Rostrum 4-segmented, first segment sometimes short (fig. 11) 24

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[1] For figures see Johannsen, Psyche, XVI, 1909, pl. i.

19. Body convex below, flat or slightly concave above; greenish in color; clavus membranous, similar in texture to the membrane, the latter without veins (fig. 21), corium somewhat thickened; usually wingless; ocelli distinct in winged form, obsolescent in wingless form; rostrum 3-segmented; tarsi 3-segmented; small aquatic predatory species living generally on floating vegetation. ..... MESOVELIIDÆ

Body usually very thin, flat above and below; when not distinctly flattened hemielytra are not constructed as above; color not greenish; terrestrial or riparian 20

20. Tarsi 2-segmented 21

Tarsi 3-segmented 22

21. Head wider just behind the eyes than immediately in front of them; eyes not projecting beyond extreme side of head (fig. 9); trochanters distinct; abdominal spiracles midway between apex and base of ventral segments: ocelli absent; rostrum apparently 3-segmented; true first segment very small, often concealed; flat dark colored species living under dead bark; moderate in size ..... DYSODIIDÆ

Head narrowed behind the eyes, eyes projecting strongly (fig. 10); trochanters connate with femora; abdominal spiracles near base of segments; other characters as in the preceding family ..... ARADIDÆ

22. Ocelli present 23

Ocelli absent; hemielytra always much reduced, without membrane; rostrum not reaching intermediate coxæ, 3-segmented; tarsi 3-segmented; parasitic on vertebrates; rather small species ..... CLINOCORIDÆ or CIMICIDÆ

23. Hemielytra provided with a cuneus, membrane without long closed cells (fig. 2), sometimes without veins; occasionally brachypterous; head horizontal; rostrum 3-segmented; tarsi 3-segmented; small predatory forms ANTHOCORIDÆ

Hemielytra without a cuneus; membrane with four or five long closed cells (fig. 3); tylus separated from frons by an impressed line; always fully winged; predatory; littoral; moderate or small in size SALDIDÆ or ACANTHIIDÆ

24. Ocelli absent 25

Ocelli present 27

25. Membrane with two large cells at base from which extend about eight branching veins (fig. 4); hemielytra without a cuneus; rostrum 4-segmented; tarsi 3-segmented; phytophagous; rather large strong forms. *PYRRHOCORIDÆ

Membrane with one or two small cells at base, very rarely with longitudinal veins; cuneus distinct; rather small delicate forms 26

26. First segment of rostrum longer than broad, extending generally somewhat beyond posterior margin of head; membrane with two small cells at base or rarely one (fig. 5); generally without longitudinal veins other than the "anal" vein; rostrum 4-segmented; tarsi 3-segmented; phytophagous, or rarely predatory; numerous common species ..... CAPSIDÆ or MIRIDÆ

First segment of rostrum little or not longer than broad, extending posteriorly not farther than middle of eyes; membrane with one cell; rostrum 4-segmented; tarsi 3-segmented; very few rare species. †TERMATOPHYLIDÆ

27. Front legs raptorial, the tibiæ and usually the femora armed with rows of numerous closely set fine spines which interlock when the leg is flexed, front femora more or less thickened (fig. 23), the femoral spines sometimes replaced by closely set even setæ; rostrum 4-segmented, the first segment short (fig. 11); membrane with a few long cells from which radiate numerous veins; sometimes brachypterous; tarsi 3-segmented; wandering predatory species of moderate size ..... NABIDÆ

Front legs not especially modified for grasping, generally much like the others, front femora sometimes thickened and armed with a few teeth; first segment of rostrum generally longer than wide 28

28. Body and appendages extremely slender, linear; antennæ geniculate, biclavate; eyes distant from base of head; ocelli present; rostrum 4-segmented; tarsi 3-segmented; inhabit underbrush; probably phytophagous; moderate in size ..... NEIDIDÆ

Body and appendages not extremely slender, antennæ otherwise constructed 29

29. Membrane with five usually simple veins (fig. 6); antennæ inserted low on the side of the head, usually below or on a line drawn from the middle of the eye to the anterior end of the buccula (fig. 24); ocelli present; rostrum 4-segmented; tarsi 3-segmented; sometimes brachypterous; phytophagous; moderate or small in size ..... LYGAEIDÆ or MYODOCHIDÆ

Membrane with numerous more or less anastomosing veins (fig. 7); antennæ inserted high, usually above such a line (figs. 25, 30) 30

30. Metasternal orifices generally obsolete, when present placed between intermediate and hind coxæ near median line, with two diverging furrows running outwards; ocelli present; rostrum 4-segmented; tarsi 3-segmented; phytophagous; colors for the most part light; moderate or small in size ... CORIZIDÆ

Metasternal orifices distinct, placed farther outward; colors usually dark; generally over 10 mm. in length 31

31. Head much narrower and shorter than the pronotum (fig. 26); bucculæ extending posterior to insertion of antennæ (fig. 25); ocelli present; rostrum 4-segmented; tarsi 3-segmented; generally phytophagous; moderate or large in size ..... COREIDÆ

Head much larger proportionally, the part between the eyes wider than the scutellum (fig. 27); bucculæ anterior to insertion of antennæ (fig. 30); ocelli present; rostrum 4-segmented; tarsi 3-segmented; form rather elongated; phytophagous (always?); moderate in size ..... ALYDIDÆ

32. Scutellum generally moderate in size, more or less narrowed apically; scutellum rarely covering most of abdomen, in which case colors are bright and contrasting, or there is a prominent tooth just anterior to lateral angles of pronotum; tibiæ not strongly spinose but sometimes bear very small spines or a more or less hairlike vestiture which may have a spinose appearance; ocelli present; membrane with many veins (fig. 19); rostrum 4-segmented; tarsi 3-segmented; phytophagous or predatory; moderate in size CIMICIDÆ or PENTATOMIDÆ

Scutellum generally large, covering almost the whole of abdomen, usually very

convex; when scutellum is reduced in size and flattened, tibiæ are strongly spinose..... 33

33. Tibiæ thickly set with long strong dark colored spines; corium narrow, acute apically (fig. 20); ocelli present; rostrum 4-segmented; tarsi 3-segmented; phytophagous (always?); generally shining black or blue, sometimes with lighter peripheral markings; rarely brownish in color, in which case length is less than 5 mm.; moderate to minute in size

CYDNIDÆ or THYREOCORIDÆ

Tibiæ not strongly spinose; corium broad, obtuse at apex; ocelli present; rostrum 4-segmented; tarsi 3-segmented; phytophagous; gray, brown or reddish species; moderate in size..... SCUTELLERIDÆ

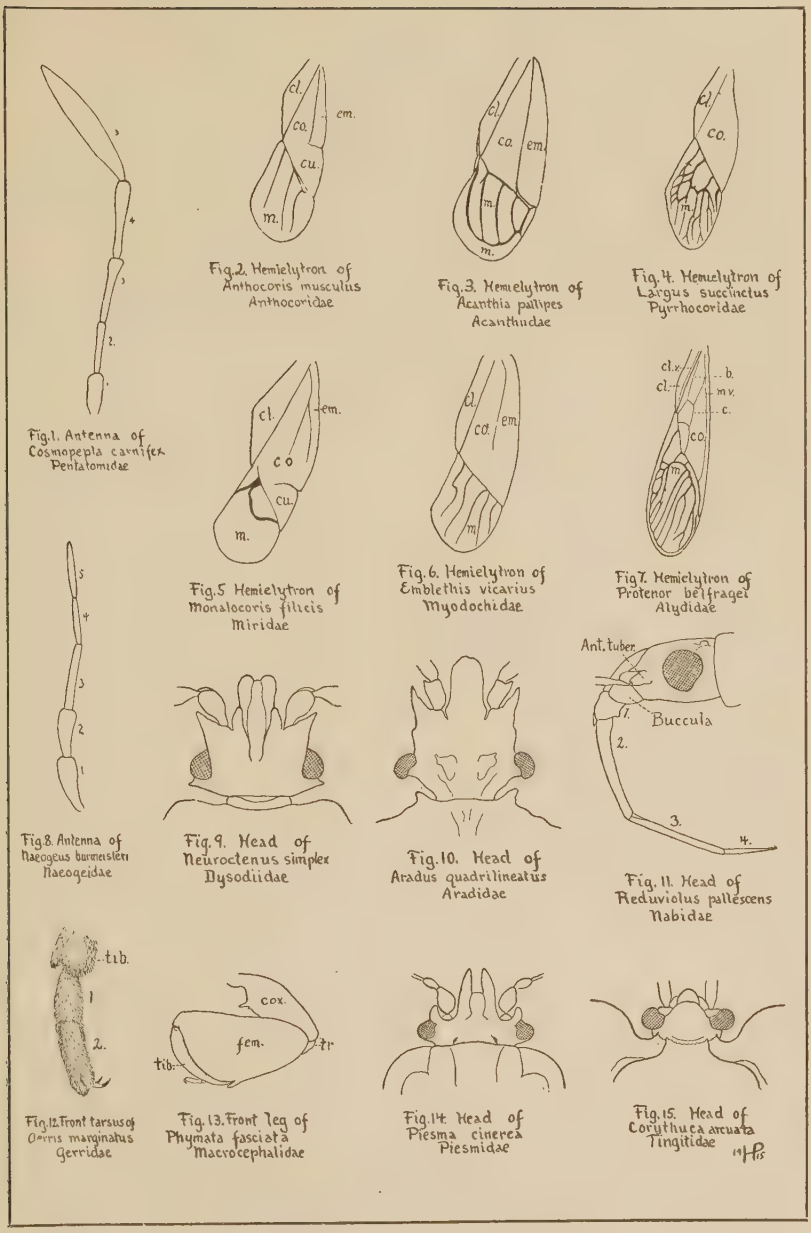
Fig.1. Antenna of Cosmopepla carnifex Pentatomidae
Fig.2. Hemielytron of Anthocoris musculus Anthocoridae
Fig.3. Hemielytron of Acanthia pallipes Acanthidae
Fig.4. Hemielytron of Largus succinctus Pyrrhocoridae
Fig.5 Hemielytron of Monalocoris filicis Miridae
Fig.6. Hemielytron of Emblethis vicarius Myodochidae
Fig.7. Hemielytron of Protenor belfragei Alydidae
Fig.8. Antenna of Naeogeus burmeisteri Naeogeidae
Fig.9. Head of Neuroctenus simplex Dysodiidae
Fig.10. Head of Aradus quadrilineatus Aradidae
Fig.11. Head of Reduviolus pallescens Nabidae
Fig.12. Front tarsus of Gerris marginatus Gerridae
Fig.13. Front leg of Phymata fasciata Macrocephalidae
Fig.14. Head of Piesma cinerea Piesmidae
Fig.15. Head of Corythuca arcuata Tingitidae

Fig. 16. Hemielytron of Gerris buenoi Gerridae

Fig. 17. Hemielytron of Leptostyla oblonga Tingitidae

Fig. 18. Hemielytron of Piesma cinerea Piesmidae

Fig. 19. Hemielytron of Mormidea lugens Pentatomidae

Fig. 20. Hemielytron of Thyreocoris unicolor Thyreocoridae

Fig. 21. Hemielytron of Mesovelia bisignata Mesoveliidae

Fig. 22. Hemielytron of Naeogeus burmeisteri Naeogeidae

Fig. 23. Front leg of Pagasa fusca Nabidae

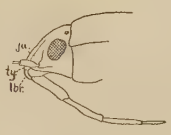

Fig. 24. Head of Emblethis vicarius Myodochidae

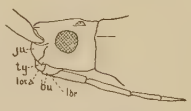

Fig. 25. Head of Chariesterus antennator Coreidae

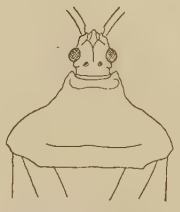

Fig. 26. Head and thorax of Anasa repetita Coreidae

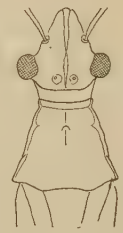

Fig. 27. Head and thorax of Alydus pilosulus Alydidae

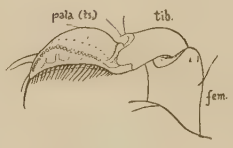

Fig. 28. Front leg of Arctocorisa interrupta Corixidae

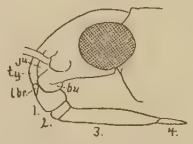

Fig. 29. Head of Gerris buenoi Gerridae

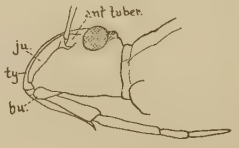

Fig. 30. Head of Alydus pilosulus Alydidae

19 Pls

VULTUROPS FLORIDENSIS, A NEW MEMBER OF THE PSOCID SUBFAMILY VULTUROPINÆ FROM THE UNITED STATES.

By G. H. CORBETT AND E. HARGREAVES.

[Reprinted from Psyche, Vol. XXII, No. 4]

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VULTUROPS FLORIDENSIS, A NEW MEMBER OF THE PSOCID SUBFAMILY VULTUROPINÆ FROM THE UNITED STATES.[1]

By G. H. Corbett and E. Hargreaves,
Carnegie Students, Bussey Institution, Harvard University.

The subfamily Vulturopinæ was erected by C. H. T. Townsend in 1912 to include a very peculiar member of the Order Corrodentia from Peru.[2] The type species, *Vulturops termitorum*, was found in the covered runways of a species of Hamitermes at Piura in northern Peru.

Recently, on examining some Aleurodidæ taken from an orange tree at Orlando, Fla., on October 1, 1914, we were very much surprised to find with them one adult specimen which is very closely related to the Peruvian form. The North American species is very similar to *V. termitorum*, but differs in wing neuration as well as in other characters and evidently represents a distinct species of the same genus.

Vulturops floridensis sp. nov.

The insect as a whole is dark brown in color, the thorax and head being darker than the abdomen, and is about 1.6 mm. in length.

Wings (fig. 1). Only one pair present. They are somewhat elliptical, 1 mm. in length, about two and a half times longer than broad; for comparison, a reproduction of the wing of *V. termitorum* is given (fig. 2). On the dorsal surface chiefly along the veins are structures resembling spine bases, although there were no traces of the spines themselves. They also occur to some extent on the ventral surface. The wing-veins are very prominent, and are accompanied alongside by areas which are probably blood sinuses (shaded in figure).

Legs (fig. 3). The hind legs are about 1⅓ times the length of the others, the coxæ, femora, tibiæ and first tarsal segment, being each respectively much longer (for comparison, see figs. 4, 5, 7). The tibiæ exhibit a kind of pseudosegmentation, each division being very finely striated longitudinally. This is also evident in the first tarsal segments (fig. 6). On the hind tibiæ are three strong spines which are absent in the two anterior pairs (fig. 5). The second and third tarsal segments are clothed with very fine hairs. The tarsi terminate in a pair of sharp, toothed claws.

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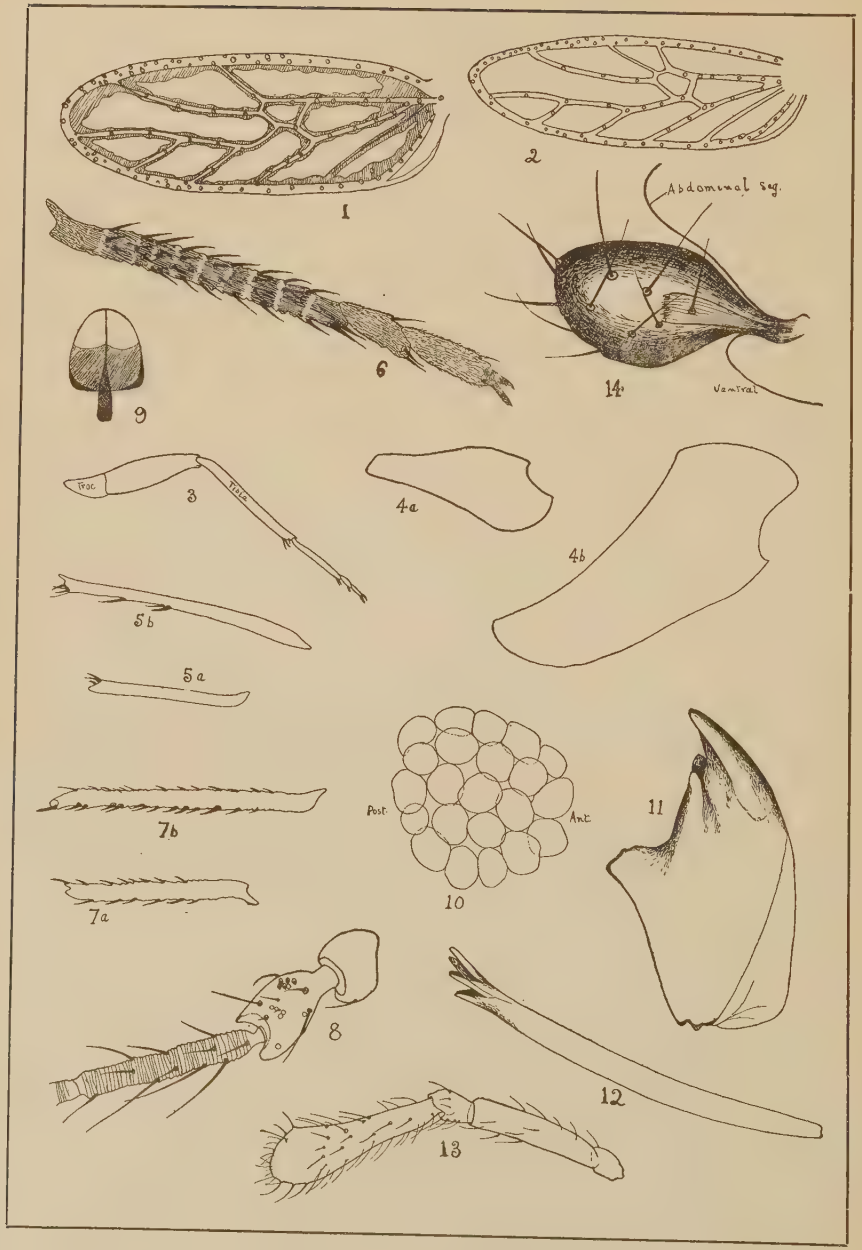
[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 92.

[2] Entom. News, Vol. 23, pp. 266–269. (1912.)



CORBETT AND HARGREAVES—*Vulturops.*

Antennæ (fig. 8). Only the basal portion is described, as the remainder was missing. The first segment is broader than long; the second longer than broad, constricted at the base and, in addition to spines, bears a group of sense organs of the Hicksonian type. One of these is shown greatly enlarged in fig. 9. The remaining segments show pseudosegmentation, and bear very long spines.

Eyes (fig. 10). Compound, with 23 facets.

Mandibles (fig. 11). Very large and heavily chitinised.

Maxillae (fig. 12). Chitinous rod-like structures, concave on the inner side towards the distal end, and terminating in three pairs of processes.

Maxillary palpi (fig. 13). Consist of four segments, the 4th being flattened and expanded towards the apex.

Abdomen. Globose, about half the length of the entire body, thinly chitinised, and bears long slender spines. On the venter towards the apex is a sac-like protrusion which is a little more heavily chitinised than the rest, and bears long spines (fig. 14). Inside the sac towards the base is a thick strand which may be muscle, or, being a potash preparation, a structure for the attachment of muscles.

EXPLANATION OF PLATE.

1. *Vulturops floridensis* sp. nov., left wing from above.
2. *Vulturops termitorum* Townsend, left wing from above.
3. *Vulturops floridensis* sp. nov., anterior leg (coxa not shown).

4a. *Vulturops floridensis* sp. nov., coxa of front leg.

4b. *Vulturops floridensis* sp. nov. coxa of hind leg.

5a. *Vulturops floridensis* sp. nov., tibia of front leg.

5b. *Vulturops floridensis* sp. nov., tibia of hind leg. (Note the three large spines, absent in 5a.)

6. *Vulturops floridensis* sp. nov., tarsus of front leg. (Note pseudosegmentation, fine striations, toothed claws, and the fine hairs on the second and third segments.)

7a. *Vulturops floridensis* sp. nov., first tarsal segment of front leg.

7b. *Vulturops floridensis* sp. nov., first tarsal segment of hind leg.

8. *Vulturops floridensis* sp. nov., base of right antenna, ventral view. (Note pseudosegmentation, sense organs on the second segment, and long spines.)
9. *Vulturops floridensis* sp. nov., sense organ greatly enlarged.
10. *Vulturops floridensis* sp. nov., eye.
11. *Vulturops floridensis* sp. nov., left mandible, ventral view.
12. *Vulturops floridensis* sp. nov., left maxilla, ventral view.
13. *Vulturops floridensis* sp. nov., left maxillary palpus, ventral view.
14. *Vulturops floridensis* sp. nov., sac-shaped protrusion on ventral side of abdomen.

All figures drawn with camera lucida by E. Hargreaves.

PARANOMOPONE, A NEW GENUS OF PONERINE ANTS FROM QUEENSLAND.

By WILLIAM MORTON WHEELER.

[Reprinted from Psyche, Vol. XXII, No. 4]

PARANOMOPONE, A NEW GENUS OF PONERINE ANTS FROM QUEENSLAND.[1]

By William Morton Wheeler.

Paranomopone gen. nov.

Worker. Rather small, monomorphic. Mandibles triangular, with toothed apical borders. Clypeus short, not produced in the middle, indistinctly marked off from the remainder of the head. This is also true of the triangular frontal area. Frontal carinæ distinctly dilated, further apart than the distance of each to the lateral border of the head, concealing the insertions of the antennæ, continued back about three-fourths the length of the head as the medial border of a deep scrobe which lies entirely dorsal to the eye. The ventral border of this scrobe, which is somewhat more than three times as long as broad, is also very sharp. Its depression is divided by a median longitudinal ridge which does not extend to the posterior end of the scrobe, so that the latter is incompletely separated into two compartments, one for the accommodation of the scape and one for the funiculus, when

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 93.

the antenna is folded back against the head. Eyes small, situated behind the middle of the head. Ocelli absent. Antennæ 12-jointed, funiculus somewhat enlarged at the tip into a 3-jointed club, which, however, is not very sharply marked off from the more basal joints. Palpi extremely short. The number of their joints could not be ascertained. Thorax small and short, with a very distinct promesonotal but no mesoëpinotal suture; epinotum unarmed. Petiole nodiform, attached to the postpetiole by a very small, narrow surface. Postpetiole voluminous, larger than the first gastric segment, constricted behind, remaining gastric segments very small, almost completely telescoped into the first segment. Sting well-developed. Legs rather stout and short; hind tibiæ each with a single large, richly pectinated spur; tarsal claws simple, slender and straight. Sculpture and pilosity rather coarse.

Female. Ergatoid and differing from the worker only in having an anterior ocellus and in the larger size of the postpetiole and first gastric segment, and in the latter being as large as the former.

Paranomopone relicta sp. nov.

Worker. (Figs. 1–4). Length 4–4.5 mm.

Head, excluding the mandibles, scarcely longer than broad, distinctly narrower in front than behind, with broadly and rather deeply excised posterior border and prominent posterior corners, its sides rather straight, its upper surface convex, the gula flattened. Mandibles with slightly convex external borders and about 7–8 subequal teeth on the apical borders. Clypeus flat, with a sharp median carina, anteriorly very slightly projecting as a short lobe with straight median border and rounded corners. Antennal scapes about three-fourths the length of the head; first funicular joint about as long as broad: joints 2-8 decidedly broader than long; first and second joints of club subequal, each about as long as broad and together distinctly shorter than the terminal joint. Thorax narrower than the head, broadest through the pronotum, which, seen from above and excluding the neck, is nearly twice as broad as long, broadest in front, with the humeral and inferior angles sharp and pointed. Promesonotal suture very sharp and distinct; mesoëpinotum from above less than twice as long as broad, its sides feebly concave, in profile scarcely longer than high, with the base of the epinotum convex and somewhat longer than the declivity, which is concave and sloping and has a distinctly crenulate margin on each side. Petiole from above broadly elliptical, slightly broader than long, with rounded sides; in profile as high as the thorax, about one and three-fourths times as high as long, with straight and perpendicular anterior, convex and horizontal superior and concave and perpendicular posterior surface. Ventral surface with a small tooth near its anterior border. Postpetiole from above and from the side rounded, as broad as long, broader and longer than the first gastric segment, which is rather cylindrical and encloses the small remaining gastric sements. There is a small blunt tooth at the anterio-ventral margin of the postpetiole.

Rather shining; mandibles smooth, sparsely and rather coarsely punctate. Clypeus with a few sharp longitudinal rugæ on the sides. Head between the frontal carinæ and medial borders of the scrobes traversed by about seven sharp longitu-

dinal rugæ on each side of the median line, which is itself represented by a ruga continuous anteriorly with the median carinula of the frontal area and the clypeal carina. The rugæ diverge on each side of the middle line and there are shallow, elongate punctures in the interrugal spaces. Cheeks also with similar, but more reticulate, coarse rugæ. On the occiput and posterior corners of the head the longitudinal rugæ are replaced by very coarse punctures or foveolæ, so close together that the spaces separating them are converted into reticulate rugæ. Thorax, petiole, postpetiole, and first gastric segment finely punctate and covered with foveolæ similar to those on the occiput but distinctly sparser on the postpetiole and gaster. Epinotal declivity, posterior declivity of petiole, scrobes of the head and a portion of the mesopleuræ glabrous and very shining, the scrobe also slightly striolate. Antennæ, legs and terminal gastric segments subopaque, finely and densely punctate.

Hairs and pubescence rather coarse, grayish yellow; the former long, erect, of unequal length, covering the body, legs and scapes and quite as long on the extensor surfaces of the appendages as on the body. Pubescence long and appressed on the body, most distinct on the gaster and postpetiole, finer and denser on the legs and antennal scapes.

Head, thorax and petiole dark brown or piceous above; mandibles, clypeus, antennæ, pleuræ, legs, sides of petiole and the whole of the postpetiole and gaster richer brownish red.

Female. (Figs. 5 and 6.) Length 5.5 mm.

Differing from the worker only in the shape and size of the abdomen, the postpetiole and first gastric segment being larger and the latter as broad as the petiole and fully as broad as long. These segments are of the same dark brown color as the head and thorax, whereas the remaining gastric segments are paler brownish red, like the legs, antennæ and mandibles.

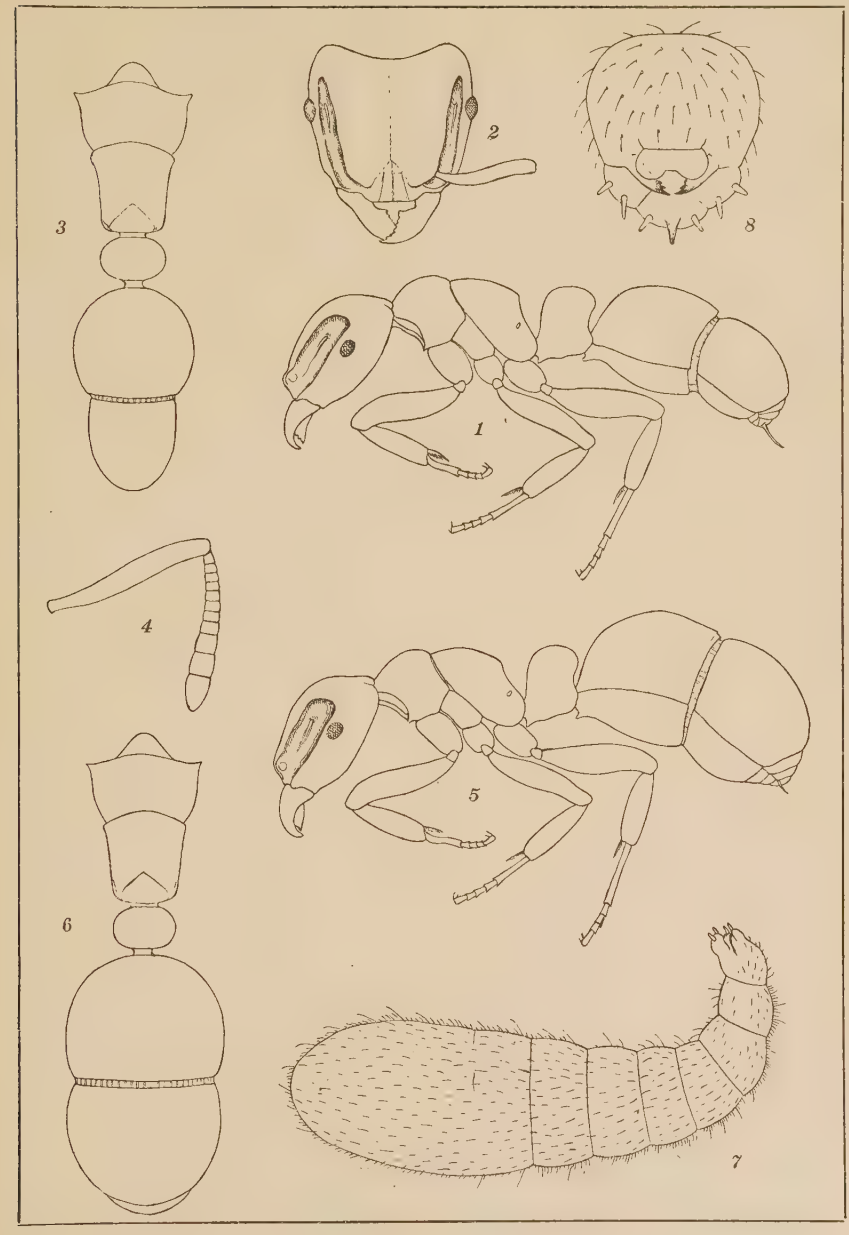
Described from a single female and two workers taken October 28, 1914, under a large rotten log in the moist tropical "scrub" at Kuranda in Northern Queensland. These specimens with a few nearly full-grown larvæ apparently comprised the whole colony. The larva (Figs. 7 and 8) is rather slender, pure white and covered with delicate white hairs, which are short and rather dense, especially on the dorsal surface, and interspersed with fewer, longer and more flexuous hairs. The head is rounded, sparsely hairy and bears a pair of well-developed, tridentate mandibles.

Paranomopone has all the ear-marks of being a very ancient, possibly Mesozoic genus, which still survives as a very rare relict in tropical Queensland. It is difficult to assign it to a definite position in any of the existing tribes of the subfamily Ponerinæ as enumerated and defined by Emery in the "Genera Insectorum." In the structure of the thorax and abdomen there is considerable resemblance to the peculiar Haytian genus *Emeryella* Forel among

the Ectatommiini, but the deep scrobes of the head are unlike anything seen in other known Ponerine genera. *Paraponera*, to be sure, has scrobes, but these are of a very different conformation, being angulate and enclosing the eye in such a manner that the scape lies over, and the funiculus under the eye, when the antenna is folded back against the head, whereas in *Paranomopone* the whole scrobe is above the eye. In other respects the head shows close affinities with the Ectatommiini, so that, on the whole, I am inclined to assign it to this tribe. The peculiar ergatoid female is of unusual interest in connection with similar females of the genera *Onychomyrmex* and *Leptogenys* and the apparent absence of definite female forms in some of the other Australian ant-genera, notably *Rhytidoponera* sens. str., *Diacamma* and *Leptomyrmex*.

EXPLANATION OF THE PLATE.

Fig. 1. *Paranomopone relicta* sp. nov. Worker in profile.
Fig. 2. Head of same seen from above.
Fig. 3. Thorax and abdomen of same seen from above.
Fig. 4. Antenna.
Fig. 5. Female (ergatoid), in profile.
Fig. 6. Thorax and abdomen of same seen from above.
Fig. 7. Nearly full grown larva.
Fig. 8. Head of same from above.



WHEELER—*Paranomopone.*

A GYNANDROMORPHOUS MUTILLID FROM MONTANA

By WILLIAM M. MANN

[Reprinted from Psyche, Vol. XXII, No. 5]

A GYNANDROMORPHOUS MUTILLID FROM MONTANA.[1]

By William M. Mann.

In July, 1912, while collecting in the Elkhorn mountains near Townsend, Montana, I found a Mutillid which presents a peculiar type of gynandromorphism. The specimen was taken with several others of the same species, which Mr. Rohwer has determined as *Dasymutilla euchroa* Cockerell. The female of this species has the body very thickly covered with long bright red hairs. The male also has these hairs on the greater part of the thorax and abdomen, and on the occipital region of the head, but the sides of the head, the epinotum, and the anterior two-thirds of the first gastric segment bear only black hairs, which are more sparse than the red ones and allow the black color of the integument to show through.

Only two gynandromorphous Mutillids have been recorded. One of these, *Mutilla europæa* L. var *obscura* Nyl., according to Wheeler (Psyche, Vol. XVII, 1910, p. 89), was divided laterally, the right side being female, the left male. The other example, *Pseudomethoca canadensis* Blake, which Wheeler found at Colebrook, Conn., differed in having the sexes of the two sides reversed, the female to the left. Both of these were complete, having well developed wings on the male side and even the legs of either side characteristic of the respective sex. The specimen before me is incompletely differentiated. The male side lacks wings, and all of the legs are typically male. It differs also in being a crossed or decussated gynandromorph. The head is male to the right and female to the left, while the thorax and abdomen are male to the left and female to the right. The body of *D. euchroa* is so densely covered with hairs that it is impossible clearly to make out the thoracic sutures or the sculpture. The accompanying figures will give an idea of the general outline of the body from above and the head from the front. The black parts of the insect are shaded in the figures.

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 94.

The right (male) side of the head is much shorter than the left. The right eye is larger than the other, the antennæ long and 13-jointed and the mandible short, with three teeth toward the apex. The median ocellus is perfect, though somewhat smaller than in an ordinary male. There is one lateral ocellus on the male side. On the female side the head is longer, the antennæ are shorter and 12-jointed, the eye small, located a little farther back than the other, and the mandible is much longer and more slender, with a

Fig. 1. *Dasymutilla euchroa* Ckll., gynandromorph.

single sub-apical tooth. The pilosity of the head is black, except for spaces on the left of the occiput and front and a few scattered red hairs on the occiput to the right of the median line (the latter characteristic of the male). The clypeus, antennæ and both mandibles are black.

Each side of the thorax is not so evidently distinct from the other as in the head, because in both sexes occurs the heavy covering of red hairs. In general shape it is asymmetrical, the epinotum is more rounded on the left side and is black along the margin. The petiole is male to the left and female to the right, and is peculiarly twisted. The differences between the sides of the abdomen are more apparent. The large black spot on the left half of the first segment is typical of the male. There is a strong constriction

on this side between the first and second segments. The apical segment is only slightly twisted and from above is essentially male in character, with two well developed stipes. Anteriorly, beneath and to the right of these, is what is evidently a short, aborted sting, without any part of its sheath.

The absence of either wings or tegulæ on the otherwise gynandromorphous thorax, the queer structure of the tip of the gaster which has both of the male secondary sexual appendages and in addition an imperfect sting, and the crossed nature of the sides are very different from the conditions in either of the previously known examples.

ON THE PRESENCE AND ABSENCE OF COCOONS AMONG ANTS, THE NEST-SPINNING HABITS OF THE LARVÆ AND THE SIGNIFICANCE OF THE BLACK COCOONS AMONG CERTAIN AUSTRALIAN SPECIES.*

By William Morton Wheeler.

It has long been known that in three of the five subfamilies of ants, the Dorylinæ, Myrmicinæ and Dolichoderinæ, the larvæ spin no cocoons before pupation, and therefore remain nude, or uncovered in this instar. There is apparently no exception to this rule in these three subfamilies. The cocoon is present, so far as known, in all members of the subfamily Ponerinæ, with the single exception of a small African ant, *Discothyrea oculata*, and is lacking among the Camponotinæ only in a few whole genera and a few sporadic species of other genera. The pupæ of the genera *Prenolepis* and *Œcophylla* are naked, and in some species of *Formica* (e. g. the circumpolar *F. fusca* L. and its vars. *subsericea* Say, *neorufibarbis* Emery, etc. in North America) one often finds only naked or both naked and cocooned pupæ in the same nest. This is also the case, though much more rarely, in certain species of *Lasius*. A few species of the large paleotropical genus *Polyrhachis* also lack the cocoon in the pupal stage, as I shall show in the sequel.

These facts naturally suggest the inference that the cocoon, inherited from the ancient wasp-like ancestors of the ants, has been retained in the most primitive subfamily, the Ponerinæ, from which, by common agreement, the four other subfamilies are descended, and that it has been lost in three and is tending to disappear in the fourth of these. Certain authors, indeed, seem to believe that the disappearance has been comparatively recent in the phylogenetic history of the Formicidæ. In this sense I interpret the following remarks of Janet (1896): "We are no doubt witnessing in the ants the disappearance of this protective envelope, which is rendered unnecessary by the incessant care devoted to the progeny. From the point of view of the evolution of instinct, it is interesting to note that

*Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 95.

the disappearance is not accomplished gradually, by successive attenuation or evanescence of the cocoon, but suddenly, so to speak, since larvæ that are similar and give rise to similar adults, make an absolutely perfect cocoon, which shows no signs of reduction, or make none at all. This may be cited as an example of the sudden changes that may supervene in the habits of an animal. It illustrates the conclusions embodied in a communication made by my brother, M. Armand Janet, to the Leyden Congress. These conclusions, deduced from considerations of rational mechanics applied to the problem of the species regarded as a position of equilibrium, tend to show that the differences obtaining between a form and its derivatives are more probably produced by rather sudden saltations than by insensible and continuous variations."

In other words, Janet regards the disappearance of the cocoon in ants as due to what we now call "mutation," and intimates that in certain species the process is still going on. I am willing to grant the partial truth of this contention, but I have recently found evidence to prove that, far from being a recent loss, the disappearance of the cocoon, in certain genera of ants at least, had already taken place not less than two million years ago. Among the Dolichoderinæ of the Baltic amber, which is of Lower Oligocene Tertiary age, I find the pupæ of certain species already lacking the cocoon, and this structure is likewise absent in a species belonging to the Camponotine genus *Prenolepis* (*P. henschei* Mayr) in the same formation (1914). Facts like these are calculated to impress us with the immense antiquity of many apparantly trivial structures and to convince us that we cannot dispense, even in these days of experimental biology, with a certain amount of "phylogenetic speculation."

What has led to the disappearance of the cocoon in the Myrmicinæ, Dorylinæ and Dolichoderinæ and in a few genera and sporadic species of other genera among the Camponotinæ? This question no doubt admits of several answers. Janet, as we have seen, believes that the cocoon became superfluous and disappeared because it was replaced by the fostering care and protection of the workers of the colony. But if this is the case, why do the most formidable of all ants, the Australian "bull-dogs" (*Myrmecia*), retain the cocoon and such feeble

species as many Dolichoderinæ (*Leptomyrmex*, *Tapinoma*, *Bothriomyrmex*, etc.) dispense with it? And why is it retained by the fierce *Formica sanguinea* and so often absent in *F. fusca* and its varieties, the gentle slaves of this ant? That the presence of the cocoon is primitive and its suppression a secondary phenomenon must be granted, and it is evident that the loss of the structure must be due primarily either to a loss of the spinning instincts on the part of the larvæ or to a change in the instinct of the adult worker ants in so far as these instincts are concerned with the treatment of the larvæ. The latter change might conceivably consist in a lapse of the habit of burying the mature larvæ in the earth or in covering them with particles of earth or refuse, since ant larvæ are known to be quite unable to spin their elliptical cocoons unless thus temporarily enveloped with foreign particles to which they can attach the thread from their sericteries.

The frequent appearance of nude pupæ in the typical *Formica fusca* and some of its varieties may be attributed to the fact that these forms are peculiar to high altitudes and latitudes, where the reproductive season of the colony is considerably abbreviated. The omission of the cocoon would seem, therefore, to be due to "tachygenesis," or acceleration of ontogenetic development, since the spinning of this envelope not only requires a number of hours and an expenditure of energy and material, and therefore delays pupation, but the envelope itself is probably in some degree a nonconductor and would therefore tend to prolong development under circumstances that demand a very rapid utilization of the sun's heat by the pupa if it is to reach maturity at the proper time. The loss of the pupal covering in the Myrmicinæ, Dolichoderinæ and Dorylinæ in the remote past may have been due to the same or similar causes.

That the behavior of the workers of the ant-colony in some species does actually influence the spinning activities of the larvæ is indicated by the following facts. In the great majority of larvæ which use their spinning glands, these organs are called into activity only at the end of the larval stage and for the purpose of making the cocoon, but within recent years several observers have called attention to a series of tropical ants belonging to at least three very different genera of Camponotinæ,

namely, *Œcophylla, Camponotus* and *Polyrhachis*, which have the extraordinary habit of using their larvæ for the purpose of spinning silken nests for the colony. This habit has been observed by Ridley (1890, 1894), Hammond (Green 1900), Green (1900, 1903), Doflein (1905, 1906) and Bugnion (1909) in the red tree-ant of India (*Œcophylla smaragdina*), by Saville-Kent (1891, 1897), Dodd (1902), O'Brien (1910) and myself in the green tree-ant of Northeastern Australia (*Œ. smaragdina* var. *virescens*), and by Chun (1903) in *Œ. longinodis* of the Kamerun. More recently Goeldi (Forel 1905) has observed this habit in a South American *Camponotus* (*C.* [*Myrmobrachys*] *senex* F. Smith) and Jacobson (Forel 1911, Wasmann 1905) and Karawaiew (1906) have observed the same behavior in several species of *Polyrhachis*. Green (1903) found that although the larval *Œ. smaragdina* is employed as a shuttle in spinning the silken portions of the nest, it does not spin a cocoon for itself, but forms a naked pupa. He says: "This seems to be explicable only on the theory that the silk that would normally be employed in the construction of the cocoon is systematically converted to the purpose of nest building, and that the larvæ have consequently lost the habit of cocoon formation." This was a natural view to take, especially as Green (1900) believed that only full grown larvæ were used in spinning the nest. The conditions, however, are more complicated than they appeared to Green, since later observers have shown that *Œcophylla* uses only its very young larvæ in nidification, and that cocoons are actually formed by the larvæ of many of the nest-spinning species of *Polyrhachis*. As I have lately had an opportunity to study the nest-spinning habits of *Œ. virescens* in Australia and am able to record a few new facts concerning an Australian *Polyrhachis* and a Central American *Camponotus* not hitherto known to produce silken nests, I take this occasion to transcribe a few observations from my note-books.

I find the earliest mention of the green tree ant in Capt. Cook's narrative of his first voyage. He landed May 23, 1770, somewhere in the neighborhood of the present Townsville, on the coast of Northern Queensland, "within the point of a bay, which led into a large lagoon, by the sides of which grows the true mangrove. There," he says, "were many nests of a singular kind of ant, as green as grass, in the branches of these

mangroves," etc. This passage came to my mind when I landed for an hour at Lucinda Point, north of Townsville, and found the nests of the green ants on the mangroves just as they had been observed by Capt. Cook. Later, while sojourning for a few weeks at Cairns on the Cape York Peninsula, I had an opportunity to become well acquainted with this ant. In the outskirts of this pretty town it may be found on all kinds of trees and bushes, building its nests in the leaves from a few feet above the ground to the inaccessible branches of the highest *Melaleuca* trees. The thorax and legs of the slender workers of *Œ. virescens* are brownish straw yellow, the gaster bright green and the head tinged with the same color. Usually it prefers trees with rather thin, flexible, lanceolate leaves a few inches in length, which may be easily drawn together, but occasionally it makes its nests even on wattles with thick phyllodes. The nests are more or less elliptical and vary in size from a few inches to a foot or more in length and to eight inches in diameter. Smaller nests or tents, for the accomodation of Homoptera, may consist of only a few leaves, but larger ones often take up nearly all the leaves on a small branch or on two neighboring branches. Some of the nests are very beautifully constructed, the leaves being drawn together and plaited in such a manner that the superficial layer forms a smooth, mosaic covering. The interior of the nest consists of the enclosed, more or less crowded or curled leaves.

On several successive days I endeavored to observe the spinning habits of *virescens* by tearing small rents in the nests and waiting to see the ants repair them. Occasionally I saw some of the workers line up on the outside of the nest as described by previous observers, and draw the leaves on each side of the rent together, but I failed to see the spinning of the silken film across the gap. On October 16th, however, I came upon a remarkable nest in process of construction. It was 3 o'clock in the afternoon and the nest hung in the shade about 8 feet from the ground on a wattle branch, which I partially broke in order to bring the structure to a level with my eyes, where I could watch it without disturbing the ants. It was very large and somewhat flattened, about 14 inches long, 7 inches broad and 4 inches thick. The leaves (or rather phyllodes) had evidently just been brought together, as the

whole outer surface was covered with hundreds of ants, all forming living sutures along the contiguous edges of the leaves. In most cases these sutures consisted of a single row of ants, side by side, with their mandibles grasping the edge of one leaf and the large claws of all their backwardly directed feet fixed into the edge of another adjacent leaf. Where the gap between the leaves of the outer layer was too wide to be spanned by single ants, there were parallel chains each consisting of two to seven ants, each ant holding the petiole of the ant in front in its mandibles and being grasped in the same place by the ant behind, exactly as described by Dodd for *Œ. virescens* and figured by Bugnion for the true *smaragdina* of Ceylon.*

The longer chains often ran diagonally across the shorter. The nest presented a startling appearance, with these hundreds of green ants immovably fixed on its outer surface and accentuating the more or less contiguous borders of the leaves. Then I noticed that there was great activity on the branch leading to the nest. Files of workers were running along it to and from the nest and could be traced to two much smaller nests consisting of dead leaves on an adjacent tree about 30 feet away. The colony had evidently outgrown these nests and was in the act of building the more commodious domicile I had been observing. Closer inspection showed that about one in a dozen of the workers coming to the new nest was carrying in its mandibles a minute milk-white larva, and as the larvæ accumulated, I was able to observe all the stages in the spinning of the silken film. Many of the ants worked from the inside, but quite a number stationed themselves on the outside of the nest where I could see them very clearly under my pocket lens, while they moved their larvæ back and forth as living shuttles from the edge of one leaf to that of another, pausing only while the larvæ attached their extremely delicate threads to the surface of the leaf. A single ant would sometimes work in the same spot for 10 to 20 minutes, moving its larva so nearly through the same arc as to produce a stout silken band or cord from the

*The question naturally suggests itself as to whether the greatly elongated petiole of *Œcophylla* is not an adaptation to this peculiar use. I have recently (1914) called attention to the fact that the fossil species of *Œcophylla* (*brevinodis* Wheeler and *brischkei* Mayr of the Baltic amber and *sicula* Emery of the Sicilian amber) have a shorter petiole than the recent *smaragdina*. This indicates, perhaps, that the species of the Lower Oligocene and Miocene had not yet acquired or were merely in process of acquiring the habit of forming chain sutures.

individually invisible threads. In other cases the movements were more varied so that the threads crossed and recrossed one another till they gradually formed a delicate film or tissue. Only very young larvæ, about 2-3 mm. in length, were employed. The nest was watched till darkness came on. There was no movement on the part of the ants that were warping and holding the stiff leaves in place, and the weaving workers were still toiling when I was compelled to return to my hotel for the night.

At nine o'clock on the following morning, when I hastened to the nest, I found few ants on its outer surface and none holding the leaves in position, for during the night the ants had filled out all the narrow spaces with white silken tissue. This must have represented an enormous amount of labor on the part of the workers and a corresponding expenditure of material on the part of the larvæ. On gently opening a few of the sutures so that I could look into the nest, I found that the chains of workers were now stationed on the inside warping the leaves while the larvæ were being employed in spinning them together to form chambers. The spaces between the leaves were full of ants and brood as the whole colony had now moved into the new quarters. The day was growing warm and the leaves of the nest were beginning to wilt as the result of my breaking the branch on the previous day.

At three o'clock I again visited the nest and was startled by the great change which it had undergone. The heat of the sun had dried the thick phyllodes of the wattle branch till they had curled and ruptured the silken tissues, so that the whole nest was disintegrated, so to speak, and had been entirely deserted by the ants. Under natural conditions the leaves of the nests also die and dry up after the ants have been living in them for some time, but so gradually as not to break the silken sutures.

When one realizes the great expenditure of labor and valuable material in constructing one of these nests, one is not surprised to find that the ants are exceedingly aggressive in defending their property. When a nest is broken open or even roughly shaken the ants rush out and gather in great numbers at one or a few points on its outer surface where they assume a peculiar threatening attitude. Doflein has given a figure of this attitude in *Œ. smaragdina*, but his figure is not altogether

accurate, at least for the var. *virescens*. This ant rises on its middle and hind legs, so that they are nearly straight, the fore pair are thrust out into the air and often waved about as if to grasp the intruder and the mandibles are opened as widely as possible. A slight shock to the nest when the workers are thus congregated will precipitate the whole mass of them over one's clothes and head. Then one may notice a peculiar method of behavior which is evidently merely a modification of the posture assumed by the ants when they are holding the leaves together during the construction of the nest. After digging the claws of their backwardly directed legs into one's skin, they seize the skin in front of them with their mandibles and begin to pull slowly and steadily. This produces a peculiar sensation as if the skin were tightly bound with cords. It is especially marked when a row of ants seizes the skin of one's neck with the mandibles and fastens the claws into the edge of one's collar.

I was unable to study the founding of the colonies of *virescens* as the ants had not yet produced their annual generation of sexual individuals at the time of my visit to Queensland, but Mr. F. P. Dodd informs me that the huge, recently fecundated queen, after cutting off her wings, takes up her abode in a curled leaf. In the course of a few days she lays a batch of eggs and when they hatch she employs the young larvæ in spinning enough silk to bind the edges of the leaf together. A figure (Fig. 135) and a few brief notes published by Maxwell-Lefroy and Howlett in their work on Indian insect-life (1909) suggest that the queen of the typical *smaragdina* founds her colony in the same manner.

The large genus *Polyrhachis* has been recently divided into several subgenera. I have found that the numerous Australian species of three of these, *Campomyrma*, *Hagiomyrma* and *Chariomyrma*, all nest in the ground under stones or pieces of wood, except *Hagiomyrma semiaurata*, which nests in great logs. The small, shining black species, with peculiarly arched thorax, now referred to the subgenus *Cyrtomyrma*, however, inhabit silken nests attached to the leaves of trees. This is true, at least, of the Australian *C. lævior* Roger and its var. *yorkana* Forel, which are merely forms of the Indomalayan *rastellata* Latreille. I found the nests of *lævior* to be of small size and usually built on thick, broadly lanceolate leaves such as those

of the mangrove and a species of *Wurmia*. Sometimes two leaves have their edges spun together with a silken tissue, or a silken bladder with a short tubular entrance is constructed on the lower surface of a single leaf. The outer surface of the silk is thickly covered with minute vegetable particles. There are only 25 to 50 ants in a colony and the pupæ are always naked. This is interesting, because all the other nest-spinning species of *Polyrhachis*, of which at least 20 are mentioned in the literature, are described as having the pupæ enclosed in cocoons just as they are in the species that nest in the ground or in logs. It is evident, therefore, that the larvæ of the subgenus *Cyrtomyrma*, like those of *Œcophylla*, though actively sericiparous in the construction of the nest, no longer spin a pupal envelope.

All the species of *Œcophylla* and *Polyrhachis* are confined to the Old World tropics. The third genus, *Camponotus*, is cosmopolitan and comprises several hundred species, nearly all of which nest in the ground or in dead wood. Only a small number of species and these, so far as known, peculiar to tropical America, build silken nests. Several years ago Goeldi (Forel 1905) observed that the Brazilian *C. senex* employs its larvæ in the construction of a somewhat globular silken nest on trees, and the var. *textor* Forel of the same ant is known to make a similar nest in Central America. I am able to add a second species, a beautiful little, opaque, red ant, *C.* (*Myrmobrachys*) *formiciformis* Forel, to the list of forms with the same habit. Dec. 28 and 30, 1911, my wife discovered two nests of this ant while we were walking in the neighborhood of Escuintla, Guatemala. One was between two broad liana leaves, which had been converted into an elliptical nest about four inches long and three inches broad by having their edges bound together with a broad film of white silk (Fig. 1). In this nest the silk was quite clean, like that of *Œcophylla*, *i. e.*, without admixture of any foreign material. The other nest, of about the same size, was of a different appearance. It consisted of silk spun around the radiating petioles of a cluster of pinnate leaves on the branch of a leguminous tree. No leaves were included in the walls of the nest so that very large quantities of silk had to be produced, and this silk was of a gray color and covered with numerous particles of extraneous vegetable matter. Each of the nests contained a flourishing colony of several hundred very active ants, which

left the nest with their larvæ and pupæ when it was violently shaken. Although I did not see the larvæ in the act of being used as shuttles in the construction of the nest, there can be no doubt that they are thus employed. The pupæ were all enclosed in white cocoons like those of other small species of *Camponotus*.

FIGURE 1

Fig. 1. Silken nests of *Camponotus* (*Myrmobrachys*) *formiciformis* from Guatemala, about one-half natural size.

The workers, however, unlike those of nearly all the species of the genus, were monomorphic as in the various species of *Œcophylla* and *Polyrhachis*. In *C. senex* the workers are also practically monomorphic, so that it would seem that the habit of employing the larvæ for spinning the nest tends to make them develop into adults of uniform stature and shape. It is not easy to understand why this should follow.

Still another inference may be drawn from the presence or absence of cocoons among the various nest-spinning ants. As we have seen, the cocoons are always present, so far as known, in *Camponotus*, even in the nest-spinning species; in *Polyrhachis* the cocoon is rarely absent and then only in the species of the subgenus *Cyrtomyrma*, whereas in *Œcophylla* it is always absent. Very few species of *Camponotus* spin nests; a number of species of *Polyrhachis* have acquired this habit, and all the species of *Œcophylla* exhibit it in its highest manifestation. This is shown also by the hypertrophic development of the sericteries of young *Œcophylla* larvæ, as observed Chun (1903) and Karawaiew (1906). Apparently, therefore, in this genus the spinning habit has been shifted back *en bloc* to an early larval stage and is no longer manifested for cocooning in late larval life; whereas in *Camponotus* and *Polyrhachis* (excepting the species of *Cyrtomyrma*) more mature larvæ are used as shuttles and the cocoon-spinning instincts have not been suppressed.* The employment of the larvæ as instruments for spinning a silken nest in at least three very different genera is only one of several cases of convergent development among ants. While studying the Australian species during the autumn and winter of 1914, I detected another case of an equally adaptive convergence in the coloration of the cocoon. In the great majority of ants the cocoons are white, cream, or pale buff-colored. In some Ponerinæ (*Odontomachus*, *Stigmatomma*, etc.) they are brown, but the cocoons of the species to which I refer are dark brown or black. Such cocoons I have found in three very different genera of Ponerinæ, namely, *Diacamma*, *Rhytidoponera sens. str.* and *Leptogenys* (subgenera *Lobopelta* and *Odontopelta*), and as nothing has been published on the habits of the species in question, I here subjoin a few of my field notes.

*Wasmann (1905), in his rendering of Jacobson's observations on *Polyrhachis* (*Myrma*) *dives* F. Sm., states that one of the larvæ used as a shuttle measured 5 mm. It must, therefore, have been much more nearly full-grown than the larvæ employed by *Œcophylla* for the same purpose. In this connection reference may be made to *Technomyrmex bicolor* Emery subsp. *textor* Forel of Java, which, according to Jacobson (Forel, 1909) inhabits, on the bark of trees, little nests 2 cm. long by 1 cm. in diameter, consisting of silk mixed with vegetable detritus. These nests are described as resembling those of *Polyrhachis psena* in miniature. If, as Forel remarks, these nests are really the work of the *Technomyrmex*, we shall have to regard this as a fourth genus which has independently acquired the habit of employing its larvæ in nidification. This would be of considerable interest, because *Technomyrmex* is a Dolichoderine ant, whereas all the nest-spinning species above mentioned are Componotinæ.

The only species of *Diacamma* known to occur in Australia is the bronzy black and beautifully sculptured *D. australe* (Fig. 2). The remainder and great majority of the species of the genus are Indomalayan. I found *australe* rather common in several localities in Queensland (Cairns, Kuranda, Koah, Townsville) nesting in the ground in open, sunny and more or less grassy places. The nests are craters four inches to a foot in diameter and two to six inches high, with a very large central opening, often 1 to 1½ inches in diameter. This opening leads almost directly into a few large chambers situated

FIGURE 2 FIGURE 3

Fig. 2. *Diacamma australe.* Workers and cocoon x1⅔.
Fig. 3. *Diacamma australe.* Male x1⅔.

in the crater, and from them galleries descend into the ground, apparently to some depth. The outer surface of the crater is often covered with growing grass or other plants. The colony of ants numbers about 50-100 individuals. They are rather timid and usually retreat into the nest at the slightest alarm. Their movements are exquisitely soft and graceful. Their sting is rather feeble, except when it comes in contact with the thin skin on one's wrists or between the fingers. In the "Genera Insectorum" Emery enumerates 13 species of *Diacamma* and one of these, the Indian *D. rugosum*, is so well known that 22 varieties and subspecies of it have been described;

yet no one has ever seen a female *Diacamma*. In excavating the nests of *australe*, therefore, I scrutinized the ants very closely in the hope of finding the unknown female, but in vain. Though I searched dozens of nests, I saw nothing resembling a winged or deälated queen or even a worker with conspicuously enlarged gaster. I found plenty of larvæ and pupæ and in some of the nests during late October a number of males. These are bright, reddish yellow, with conspicuously long antennæ, and quite unlike the bronzy black workers. (Fig. 3). As I failed to find any differentiated queen and as all the pupæ were of the same size, I feel confident that in *Diacamma* the egg-laying function must be usurped by one or more fertile workers during the breeding season.

What impressed me most, while I was excavating the nests of *australe*, was the very dark brown or black color and tough consistency of the cocoons. I then remembered that I had received very similar cocoons with specimens of *D. scalpatrum* from India and of *D. cyaniventre* from the Philippines. Further study of the nests of *australe* soon gave a clue to the meaning of this unusually deep pigmentation of the pupal envelope. On the outer surface of two of the craters, which happened to be in shade at the time, I found heaps of cocoons fully exposed to the light. At first I supposed that they were the cocoons of dead or hatched pupæ, but on approaching the nests the wary workers at once carried them into the nest. Then on examining nests exposed to the bright sunlight, I found the cocoons in the superficial chambers so near the large entrance that they could be distinctly seen through it from the outside. Thus while the ants are careful not to place their cocoons in the direct rays of the sun they nevertheless expose them to diffuse daylight. The deeply pigmented cocoon evidently enables the pupa to utilize the heat rays while effectively protecting it from the light and ultra-violet rays. That ants are particularly sensitive to these latter rays has been proved by the experiments of Lubbock (1882), Forel (1886), Forel and Dufour (1902) and Miss Fielde (1904).

It occurred to me that the *australe* larvæ might spin a white cocoon like other ants and subsequently smear or saturate it with the black meconium, or intestinal contents, which all ant larvæ void just before pupating. But an examination of the cocoons showed this supposition to be erroneous, for the silken

threads of the cocoon are themselves dark brown and the meconium is deposited in a compact meniscoidal mass within the anal end of the cocoon as in other Ponerinæ and in the Camponotinæ. This differs from the conditions in certain moths (*Attacus atlas*, *Calosamia cynthia*, *Platysamia cecropia*, *Saturnia pyri*, *Eriogaster lanestris*) which, according to Batensen, Schawraw, Peterson, Dewitz, Verson and others, are able to adapt the color of their cocoons to that of the objects to which they are attached. In these cases the silk is white or colorless, but is stained by a dark excretory pigment mechanically

FIGURE 4 FIGURE 5

Fig. 4. *Rhytidoponera convexa*. Workers and cocoon x1⅔.
Fig. 5. *Rhytidoponera* sp. Worker and cocoon x1⅔.

applied to the threads as a result of the light stimulus acting directly on the spinning caterpillar. The larva of *Diacamma*, however, cannot thus be stimulated by the light to spin a dark-colored silk, because the cocoon is completed in the darkness, while the larva lies buried in the earth.

Negro or melanic cocoons, like those of *Diacamma*, occur also in many if not all species of *Rhytidoponera sens. str.*, (Figs. 4 and 5), a genus largely confined to Australia and New Guinea. The nests of *Rh. cristata* Mayr, *scabra* Mayr and *convexa* Mayr, with the var. *rufiventris* Forel, are very similar to those of *Diacamma australe*. They are craters with very large openings, built

in dry, open, sunny places and containing roomy chambers in which the black cocoons are often visible from outside the nest. I saw many nests of these ants in Queensland, especially in the environs of Brisbane, Townsville and Kuranda. In Kuranda I also found several species of *Leptogenys* of the subgenera *Lobopelta* and *Odontopelta* (*conigera* Mayr, *ebenina* Forel, *diminuta* Forel and its var. *yarrabahna* Forel and *turneri* Forel), which had very dark brown cocoons. These ants nest under stones and logs, but they seem to be very restless and one occasionally comes upon colonies moving to new nesting sites. At such times they carry their cocoons concealed underneath their bodies and between their legs and not held out in front as in other ants. It would seem that this concealment of the cocoons under the body is another devise for protecting them from the too direct rays of the sun. In this connection I may say that our single North American species of *Lobopelta* (*L. elongata* Buckley of the Gulf States) has brown cocoons, darker than those of our other ants, but paler than those of the Australian species. Other Australian Lobopeltas, such as *L. mutans*, which has small eyes and lives in rotten logs in the dark jungle, have pale brown cocoons. It is also worthy of note that winged females do not exist in *Rhytidoponera sens. str.* and *Leptogenys*. In the latter genus the female is wingless and almost exactly like the worker, and the egg-laying function in *Rhytidoponera* is very probably usurped by fertile workers as in *Diacamma*. Whether or not this correlation between the presence of black cocoons and the absence of differentiated females is more than a mere coincidence can be decided only by further investigations.

The fact I wish to emphasize is that the larvæ of *Diacamma*, *Rhytidoponera* and *Leptogenys*, while temporarily buried in the soil by their worker nurses, are able to spin cocoons preadapted in color to furthering their own development as pupæ by utilizing the heat of the sun and simultaneously excluding the deleterious light and ultra-violet rays. This utilization, moreover, is possible only through the co-operative agency of other individuals, *i. e.*, the worker nurses of the colony. The natural selectionist will probably insist that the origin of this melanism in an inert and extraneous pupal envelope can be explained only on the assumption of a survival of chance variations in the color of the silk spun by the larvæ. The possible contention of

the mutationist that a sudden and pronounced deepening of color of the cocoon would be necessary to insure the survival of the pupa will have little force, because even slight differences in color in the direction of greater opacity would be conceivably useful. But no variations would be significant unless the workers developed concomitantly the instinct to expose the cocoons to the heat and light on the surface of the nest. The neovitalist might claim, therefore, that the whole phenomenon is merely another instance of the prospective potency of the colonial psychoid. The modest naturalist who does not habitually abide in this tenuous atmosphere of supreme speculation will be satisfied to regard the melanism of the cocoons as a detail of the larger subject of the coloration of ants in general. As almost nothing has been published on this subject I may be permitted to consider it briefly in these concluding paragraphs.

Adult ants range in color from pale yellow (the primitive color of chitin) through various tones of red and brown to black and, through interference colors superadded to pigmentation, from bronze or æneous, through metallic green, blue and violet to metallic crimson. As here enumerated the shades evidently represent the order of the phylogenetic development of insect coloration generally, as indicated both by the ontogenetic sequence and the comparative study of the various species and genera. It is not so generally known that both the pigment and interference colors may be shown to depend intimately on the amount of light to which the ants are subjected and therefore on their mode of life.

The primitive, ancestral colors of the Formicidæ were probably red, brown or black, precisely those still prevalent in the majority of species inhabiting temperate regions or the forested portions of the tropics, where the workers, while foraging on the surface of the earth or of the vegetation, are exposed to a moderate insolation. From this condition we can trace three divergent lines of development, each terminating in a peculiar type of coloration, as follows:

1. A number of species have greatly exaggerated the negative phototropism, which is characteristic of most ants, and have therefore taken to a nocturnal or hypogæic mode of life. In all of these forms pigment has been lost, and the workers of the hypogæic species, which never come to the surface of the ground,

have become pale yellow or pale red or brown. Their eyes have diminished greatly in size or have disappeared. The males and females of these hypogæic forms, however, retain their deep pigmentation and large eyes because they retain the instinct to mate in the sunlight. The principal groups of hypogæic ants which exhibit this retrogressive color-development, at least in the workers, are: *Solenopsis*, (most species), *Machomyrma*, *Oligomyrmex*, *Carebara*, *Tranopelta*, *Aëromyrma*, some species of *Pheidole* and *Crematogaster*, the whole tribe *Dacetonii*, *Brachymyrmex* and the yellow species of *Lasius*, *i. e.*, those of the circumpolar subgenus *Chthonolasius* and of the North American subgenus *Acanthomyops*, many small Ponerinæ, *Ænictus*, *Dorylus*, some species of *Eciton*, *Leptanilla*, etc.

2. A number of species exhibit a progressive development from red, brown or black to the interference colors. This tendency to what may be called "metallescence" is observable in ants living in very hot, dry, sunny places, and is most pronounced in Australia, where it occurs in the following genera: *Chalcoponera* (nearly all species), *Rhytidoponera* (*convexa* var. *violacea* Forel), *Myrmecia* (*tarsata* F. Sm.), *Diacamma*, *Lobopelta* (some varieties of *conigera* Mayr), *Iridomyrmex* (many species, notably *detectus* F. Sm., *discors* Forel, *bicknelli* Forel, *cyanea* Wheeler, etc.), *Leptomyrmex*, *Camponotus* (some species of the subgenus *Myrmocamelus*), *Calomyrmex* (*splendidus* Mayr, *purpureus* Mayr and an undescribed species from the Cape York Peninsula), *Melophorus* (*æneovirens* Lowne and others), and *Polyrhachis* (*hookeri* Lowne, *schencki* Forel and *turneri* Forel). Some of the most conspicuous and widely distributed Australian ants, such as *Iridomyrmex detectus*, which is beautifully metallic purple, and other smaller species of the same genus, may be seen running about in the sunlight at a temperature of 115° to 120° F, when other ants are hiding in the soil, and in the deserts of Central Australia, where the temperature may rise even higher and the aridity is excessive, the tendency to metallescence is still greater. It is in this region that *Calomyrmex splendidus* and *purpureus* and their varieties occur and that *I. detectus* takes on the pronounced metallic green color of the var. *viridiæneus* Viehmeyer. The prevalence of interference colors in Australian ants is in marked contrast with their rare and sporadic occurrence in other regions. They occur in

none of the ants of the temperate zones, with the exception of a species of *Forelius* (*chalybæus* Forel) in Argentina and a species of *Pheidole* (*Ph. metallescens* Emery) in the Gulf States. Nor does metallescence occur in the ants of the tropics outside of Australia, if we except a few species of *Diacamma*, *Leptogenys* and *Polyrhachis* in the Indomalayan region, a few species of *Monomorium* and *Formica* in Mexico and several species of the genus *Macromischa* which has its center of distribution in the Antilles.

3. A third progressive line of development has led to certain large-eyed tropical ants, in which there is a contrast of black, yellow or red in bands, spots or larger areas involving certain segments or regions of the body. This diversification of color is often secured or enhanced by the development of areas of dense white or golden pubescence or pile, especially on the gaster. The tints are more vivid than in the ants of the first and most primitive category, and seem to indicate that their large-eyed possessors have some slight appreciation of color for its own sake, like the butterflies and many flower-frequenting flies and beetles. These ants live in open forests and are often very quick in their movements. They comprise such genera as *Pseudomyrma* in the New World tropics, *Opisthopsis* and *Podomyrma* in Australia and New Guinea and the "bull-dog" ants (*Myrmecia*) of Australia, Tasmania and New Caledonia. We may also include in this category many tropical species of *Camponotus*, *Polyrhachis* and *Dolichoderus*.

Not only is the coloration of ants thus influenced or determined by light, heat and aridity, but a peculiar adaptation in the investment, or pilosity and pubescence is observed in many species which are subjected to the extremes of these conditions in desert regions. Thus the species of *Deromyrma* (*cockerelli* André and *albosetosus* Mayr), of *Pogonomyrmex*, *Messor* and *Myrmecocystus*, the dominant forms in the deserts of our Southwestern States, are covered with silvery white hairs or pubescence or with both, and in the Sahara similar conditions prevail in *Cataglyphis* (formerly *Myrmecocystus*) and *Messor*. *Cataglyphis bombycina*, the most extreme of these forms in the development of pubescence, when running over the desert sands in the bright sun-light is said to resemble a drop of quicksilver. Obviously the brilliant white hairs serve to

reflect the light and heat and thus protect the ants' body from the effects of excessive insolation. Even within the confines of some of our common North American species that have developed local races or varieties, we observe a lack of pubescence in the forms inhabiting moist, shady localities and a great increase in the density of the delicate hairs constituting the pubescence in the xerothermal forms. One example, the common circumpolar *Formica fusca*, must suffice. The typical form of this ant and its vars. *gelida* Wheeler, *neorufibarbis* Emery and *subœnescens* Emery are found only in rather damp, shady places in the far north or at high elevations, and have very short, feebly developed pubescence, while the much more pubescent vars. *neoclara* Emery, *marcida* Wheeler and *argentea* Wheeler are peculiar to the xerothermal slopes of the Rocky and Sierra Nevada Mountains. In even dryer and warmer localities these forms are replaced by the still more pubescent vars. of *F. cinerea* culminating in the subsp. *pilicornis* Emery, in which even the eyes are pubescent. *Formica fusca* var. *subsericea*, which is intermediate between such forms as the typical *fusca* and the vars. of *cinerea*, is the form everywhere common in the Atlantic and Middle States, in open woods and pastures where there is a moderate amount of moisture and sunlight. In Eurasia a very similar series of varieties occurs in similar correspondence with moist, moderate and extremely xerothermal conditions. (*F. fusca s. str.* and the forms *picea*, *gagates*, *glebaria* and *F. cinerea* with several varieties). Many other examples of this peculiar increase of pubescence and pilosity in ants, with an increase in the aridity and insolation of their habitat might be cited, but a more exhaustive treatment of the subject would consume much time, and, I fear, prove to be rather wearisome to my readers.

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NOTES ON THE CAT FLEA (*CTENOCEPHALUS FELIS* BOUCHÉ).

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By Harold Lyon.

The following observations were made in connection with some attempts during the past winter to devise a satisfactory method for the propagation of fleas to be used for experimental purposes. It had been intended to make use of the reared insects for experiments concerning their possible association with anterior poliomyelitis (infantile paralysis), but as it was not possible to secure proper facilities for this work at that time, it has seemed advisable to publish earlier some of the observations.

These relate primarily to the seasonal abundance of the cat flea, since it is difficult to obtain from existing literature any adequate data upon the relative abundance of fleas during the various months of the year, in regions where there is a considerable annual range of temperatures. The association between bubonic plague and various fleas, particularly the tropical rat flea (*Xenopsylla cheopis*) has long been known as well as the rôle of *Ceratophyllus fasciatus* in transmitting plague in the more temperate regions of the northern hemisphere. However, most of the work on plague and fleas has been done in the tropics or subtropics and the careful data collected in such climates cannot be applied to the conditions which exist in our own region. Observations on the seasonal prevalance of *Ceratophyllus fasciatus* have been made notably in England by Nuttall and also in California by Mitzmain, but none seemed sufficient for the present purpose. It was therefore determined to make a uniform series of counts of the number of fleas occurring on cats in the city of Boston from week to week during as long a period as possible. With the kind permission of Mr. Huntington Smith of the Animal Rescue League, it was possible to examine the cats collected by the officers of the league and these examinations have formed the basis for the accompanying tabulations. The data on seasonal distribution begin with December 1914 and have continued to the present date of writing.

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No 96.

Soon after the animals had been killed, their fur was carefully gone over with a fine-toothed comb and the fleas present on each were counted. As the time was limited, five cats were chosen as a unit. These were selected at random and the lot contained both homeless and strayed pet cats. The extent of infestation varied greatly, but contrary to expectations seemed to be as great in the pets as in the homeless ones. No doubt, more fleas could have been obtained from individual cats if it had been possible to examine each animal exhaustively, but as all were gone over with the same thoroughness, the conclusions as to the comparative abundance can be regarded as trustworthy.

The data obtained have been summarized in the following table:

Number of animals examined	139
Number of animals with fleas	114
Number of animals without fleas	25
Total number of fleas	590
Greatest number per cat	30
Smallest number per cat	1
Average number per cat	4.24

Monthly Average per Cat.

December	3.75
January	3.85
February	2.3
March	1.08
April	2.52
May	3.1
June	3.98
July	10.05

A number of very interesting facts are brought out in the table, and some are rather different from what had been anticipated. It is, of course, common experience that fleas are less abundant in the winter than in the summer, but so great a variation had not been expected, since the adult insects would not seem to be greatly affected by temperature, living as external parasites of a warm blooded animal. The larvæ are, of course, subjected to a much greater range of temperature, as they live in the nest of the animals which they infest or in accumulations of dust and animal refuse nearby. This probably accounts for the late appearance of considerable numbers of fleas in the spring, while their persistence well into the winter may be due to the continued warm environ-

ment of the adults on the body of their host after the onset of cold weather.

Some years ago Conn of the Connecticut State Board of Health (*Rept. State Bd. Health*, Conn., 1910–11 (1912) suggested a possible etiological connection between fleas and anterior poliomyelitis, but others have not been able to harmonize the persistence of fleas through the winter with the very slight incidence of poliomyelitis during this part of the year. Thus, in considering any possible insect carriers of this disease, Brues and Sheppard (*Journ.*

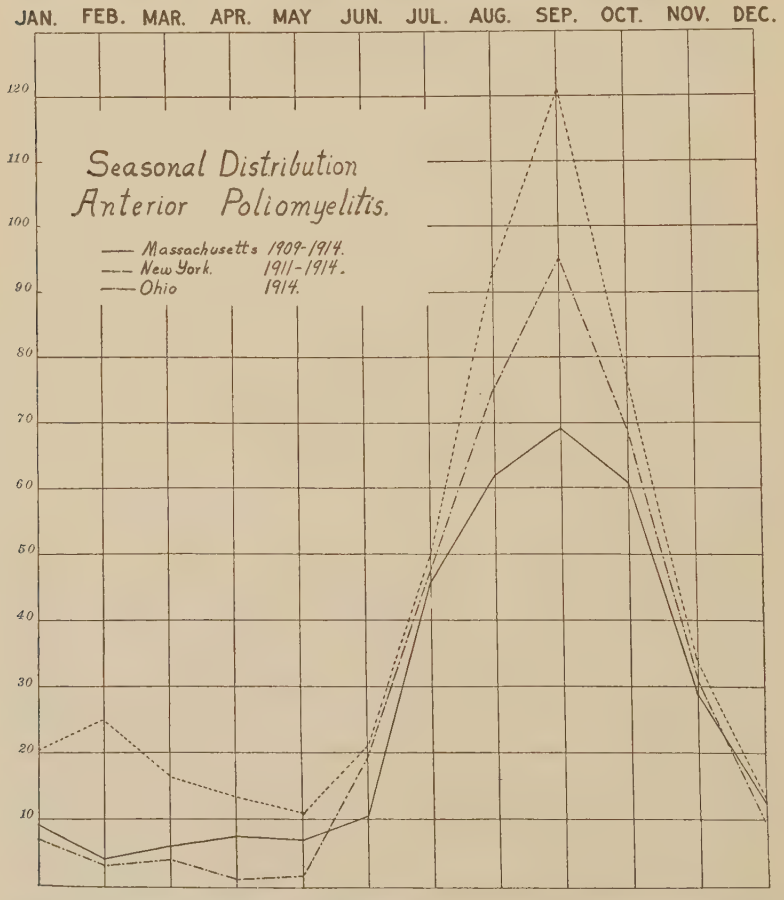


Table 1. Seasonal Incidence of Anterior Poliomyelitis in Massachusetts, New York and Ohio.

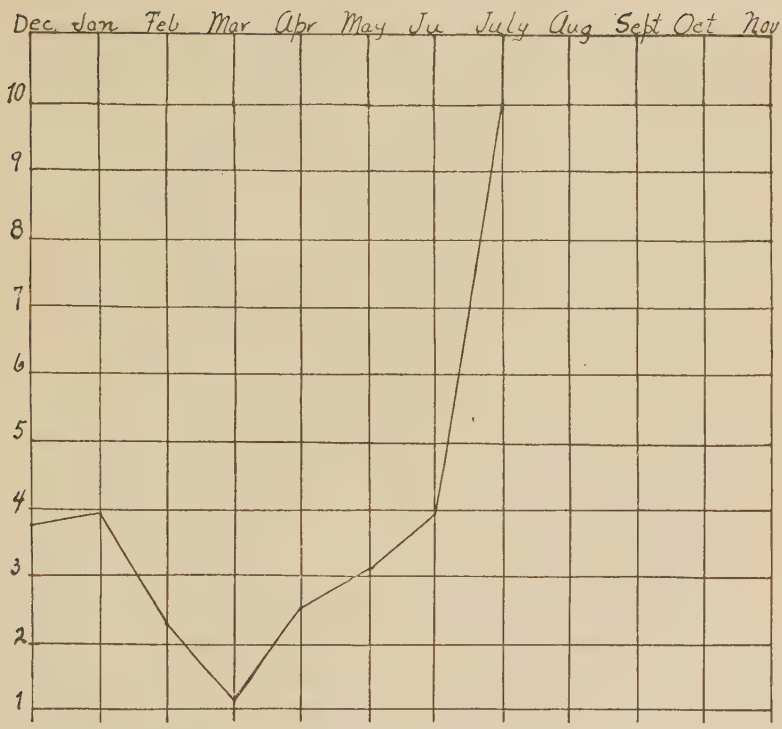


Table 2. Seasonal Abundance of the Cat Flea (*Ctenocephalus felis*).

Econ., Ent., Vol. 5, p. 314 (1912) were led to disregard fleas for this reason. The present data show, however, that in a climate like that of New England the seasonal prevalence of these insects agrees, in some respects at least, quite well with the seasonal incidence of the disease. The relationship which exists is shown graphically in the following tables (Tables I and II), in which are observed the abundance of the cat flea and the reported incidence of poliomyelitis. The data concerning the disease have been collected from a number of sources and relate to several states so as to minimize, as far as possible, any irregularities which might arise from the small numbers of cases reported during the winter months.

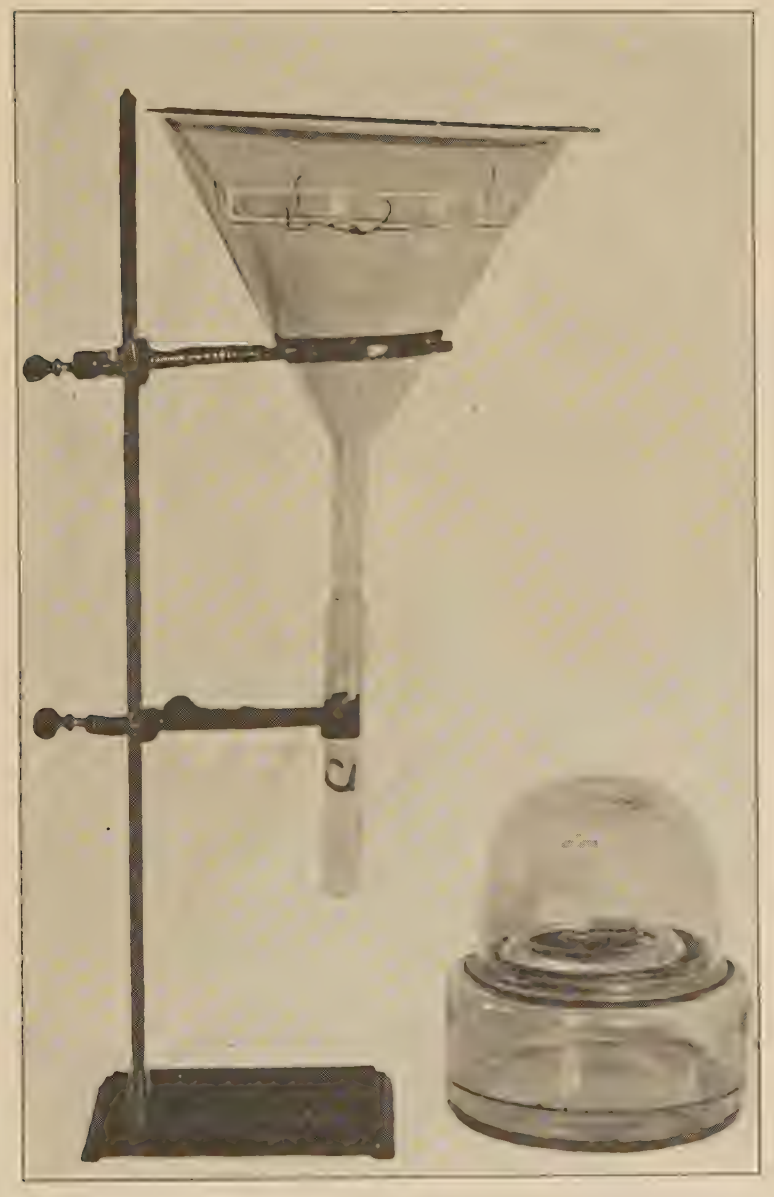
In the reports of the Massachusetts State Board of Health on Infantile Paralysis for the years 1907–1912, we find the following

information bearing directly on the question. As the majority of the domesticated animals may harbor fleas of various species, we find that in 1909–10 out of 328 families where the disease was reported, there were no animals present in 131 cases, that there were animals present in 197 cases and that 125 animals had sickness or death in 70 of the families. In this instance there were animals present in 60 per cent. of the families. Again in a later report we find that "out of 186 families in which acute epidemic poliomyelitis occurred, 34 homes had illness, paralysis or death in 82 animals. One hundred and ten of the families above mentioned had animals; therefore, about thirty per cent. of 110 families with animals, had paralysis or death in their animals." All animals in this case except two may bear fleas. Again, out of 33 cases, all of which had animals present, there were 28 cats and dogs in the home. It was also reported that out of 328 families where vermin, insects, rodents, etc., were present, there were 224 with rodents, which are common hosts of fleas.

Method of Raising Fleas.

The adult fleas after each combing were brought to the laboratory and various trials were made to keep them alive but under no condition, moist or dry, did they live after five days. As this would not do for obtaining material for experimental purposes two cats infested with fleas were secured and these were kept in the insectary until the last of May when they were placed out of doors. Their bed consisted of several layers of newspapers which were shaken every few days into a dish, and thus from fifty to one hundred eggs were obtained each time.

The following method proved most successful in raising fleas from the eggs. The eggs with the débris, etc., from the beds, were put in Petri dishes and these placed on the stage in small moistening jars, one-third full of water (Plate X). The cover was put on the jar and the whole apparatus placed out of the direct light in the laboratory at ordinary room temperature. On exceptionally warm days the jar was partly opened to prevent the condensation of moisture in the jar from drowning the larvæ. A little floor sweepings from a vacuum cleaner and sometimes a little dried blood were added to the culture. The larvæ seemed to prefer the dust and their own molt skins to the dried blood. By this method



LYON—*Cat Flea.*

we were able to raise a generation, from egg to imago, in thirteen days as the minimum to thirty-three days as the maximum, depending upon the temperature. Moisture is essential for good results.

Table Showing Time of Development.

Egg.	*Larva.*	*Pupa.*	*Complete generation.*
2–8 days	7–18 days	2–14 days	13–33 days

In order that we might easily collect the adults on emerging, the following device was used. After the larvæ had pupated (in pupating, the larvæ may spin a thin cocoon or may pupate without doing so, in either case the pupa stage is the same), the whole culture was suspended in a glass funnel, deep enough down to leave a clear space around the sides and not touching a glass plate cover which was placed over the top of the funnel. The tube of the funnel was inserted in a test tube and the entire apparatus attached to a ring stand. The fleas on emerging from the pupa jumped about and finally fell into the funnel and slid into the test tube below, where they could be easily collected and handled (Plate X).

Observations on the Anatomy of the Larva.

The statements and figures of the earlier authors, Laboulbène, Künckel and Taschenberg, are very indefinite but form the basis of most of the later work. In the first larval stage, the head is considerably longer than the other segments but in the last, third stage, it is of the same size. The egg breaker is lost after the first molt but the mouthparts remain the same.

The broad convex upper lip or labrum of the mouth of the cat flea is slightly emarginated in the middle with two small setæ at the center of either lobe (Fig. 1 C.) There are also two small hairs on either side. The labrum is used extensively in locomotion and in connection with the rest of the head to lift and turn over particles of food and in burrowing. In locomotion the two small setæ or bristles are fastened into the surface upon which the lava may be, and act as a brace while the "caudal stylets" at the extremity

of the body are being placed in preparation for exerting the power to force the body forward. The labrum is then relaxed and the larva darts forward in a rapid wriggling motion. On the under

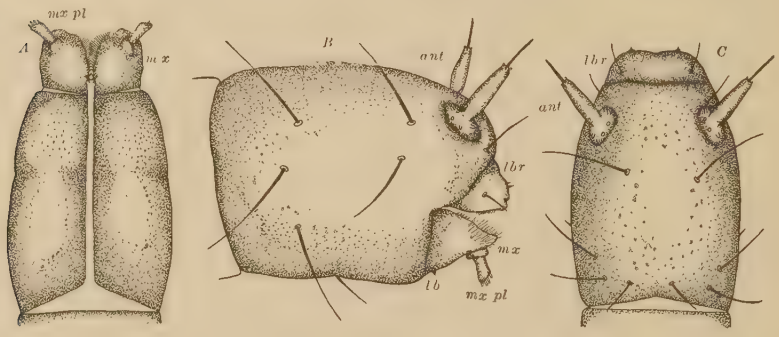


Fig. 1. *Ctenocephalus felis*, head of larva: *A*, ventral view; *B*, lateral view; *C*, dorsal view; *ant.*, antenna; *lb.*, labium; *lbr.*, labrum; *mx.*, maxilla; *mx. pl.*, maxillary palpus.

side of the labrum is a curved row of bristles which partially line the upper surface of the mouth and when closed meet the bunches of bristles on the ends of the maxillæ, thus holding the food in place in front of the mandibles.

The biting mandibles (Fig. 2 A), which are situated well inside the mouth, are strongly chitinized, broad and triangular and seem to be very powerful for such a larva, appearing more like those of Coleoptera than Diptera. The outer small end tapers gradually back and ends in a broad base with a single large lobe. The teeth appear, when the mandibles are in normal position, to be situated, not on the inside edge but somewhat back and on opposite sides of each mandible. Thus, when the two mandibles are closed, they overlap each other. The teeth, six in number, are blunt and not sharp, as Künckel states, nor do the mandibles end in a sharp point. The

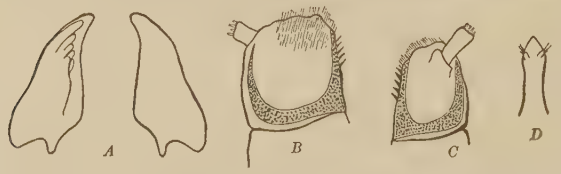


Fig. 2. *Ctenocephalus*, mouthparts of larva. *A*, mandibles; *B*, maxilla from inner side; *C*, maxilla from outer side; *D*, labium.

lobe at the base of the mandibles serves for the attachment of muscles and as a pivot by which they are moved.

Künckel describes the maxillæ (Fig. 2 B and C) as being sec tors of a circular saw with the teeth on the greater part of their outline; Taschenberg, as being sickle-shaped on the outer edge, circular in shape on the inner edge which is provided with numerous fine teeth. The two maxillæ are provided on their inner cutting surfaces with five sharp-like saw teeth which point upwards. On the ends of the maxillæ are clumps of fine bristles or "brushes." These work against the curved line of hairs on the roof of the mouth. The bristles on the outer surface of the maxillæ interlock when in normal position. In the basal portion of the maxillæ, is a part, more heavily chitinized than the rest, which tapers up into a point on either side. Perhaps this is the sickle-shaped affair of Taschenberg. This is evidently a brace for the maxillæ, providing a suitable support for the attachment of muscles at the base and for the support of the palpi, which are two-jointed. The basal joint is short, broad and higher at one end than at the other. The second joint is short and stout, enlarging at its tip an oblique, flat end, bearing five small papilliform processes of unequal length which radiate somewhat.

The labium is situated well under the head (Fig 2 D). Laboulbène says that it is boat-shaped and divided in front, with two palpiform lobes. Künckel says that it is tongue-shaped with two very fine points making it bifid, having at its base two humps provided with two long and two short bristles. The labium is very small, narrow, slightly swelling near the end, with a blunt point which is turned upwards. Its bifid appearance is due to the presence of the labial palpi which are situated just back of the tip on the slightly enlarged portion and not at the base of the labium. The palpi consist of a short thick basal joint with four stout bristles, two of which are short and appear almost together, while the other two are longer and spreading. Like the terminal bristles of the antennæ, they do not taper. The base of the labium appears to end in the suture which extends medially the full length of the under side of the head.

In conclusion I wish to thank Professor C. T. Brues for his help in preparing the introduction and for the kindly interest which he has shown during the entire work.

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NOTES ON THE EXTERNAL ANATOMY OF *BOREUS BRUMALIS* FITCH.

By S. M. DOHANIAN.

[Reprinted from Psyche, Vol. XXII, No. 4]

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NOTES ON THE EXTERNAL ANATOMY OF *BOREUS BRUMALIS* FITCH.[1]

By S. M. Dohanian.

In December, 1914, and January, 1915, a score or more of *Boreus brumalis* Fitch were found by Mr. Richard Mead in Weston, Mass., near the base of an oak tree. Another was found by the writer during the latter part of January in the Arnold Arboretum, Jamaica Plain, Mass., on melting snow near a brook. Investigation of this curious and interesting insect has called attention to

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No 97.

the fact that very little is known about its habits and that it has never been carefully figured. To fill this want and to avoid such confusion in the identification of the members of this genus, as has recently occurred among a group of amateur entomologists in Germany,[1] the writer has undertaken to figure *B. brumalis* Fitch as carefully as possible and to redescribe it from the many specimens available, particularly as these show certain variations from the original description of Fitch.

The genus Boreus, first described by Latreille in 1825, contains ten or eleven recognized species. Of these only four are to be found in the United States, two in the eastern and two in the western parts of the country. The remaining ones are distributed over Europe and Asia.

Boreus brumalis was described many years ago by Asa Fitch (1847), accompanied by some notes on its occurrence in New York state. At the same time he described a second species, *B. nivoriundus*. Fitch's paper contains the first reference to the occurrence of Boreus outside of Europe. Both of the above species are to be found in New England, as there are in the collection of the Boston Society of Natural History specimens[2] from Jackson, N. H., Medford, West Roxbury and Stoneham, Mass., to which should be added also Weston and Jamaica Plain, Mass.

The life history as yet has not been worked out completely for any of the species of the genus, but they are all believed to be predacious on other winter insects and also those found hibernating under mosses, stones, etc. Friedrich Brauer, having found some larvæ of *B. hyemalis* L. in moss in 1856, believes that the life cycle covers a period of one year: the imago appears about the middle of October and remains in the adult state through the winter until April of the following year; early in the summer, about June, the larvæ hatch, undergo a rapid development, and remain in the full grown condition until the end of the summer; then they pupate and emerge as adults very soon thereafter; these are at first rather pale-colored and immature, an observation which is corroborated by both Dalman and Stephens from immature adults that were found by them in England under stones and moss (Westwood: Introd. Mod. Class. Ins., II, p. 54).

[1] Entomologisches Jahrbuch für 1915, 24 Jahrgang, pp. 141–143.

[2] Mr. C. W. Johnson very kindly loaned these specimens to the writer.

Although they are saltatorial, their legs are not developed as are those of Orthopterous insects. The legs are extremely slender and long, the hind pair decidedly longer than the total length of the body.

Boreus brumalis Fitch.

Female. Length 3–3.75 mm., including ovipositor; polished, deep black-green; legs, antennæ and rostrum black and polished, but reflecting the light very feebly; ovipositor brilliantly polished, pure black. Antennæ inserted near the middle of the front, their bases nearer to margin of eyes than to each other; filiform; 2.15 mm. long; 22-, sometimes 23-jointed; the basal and second joints stout, slightly longer than wide; other joints one and one-half times as long as wide, gradually decreasing in length, but not in width, as the tip is approached so that the penultimate joint is about as long as it is wide; terminal joint ovate. Ocelli absent. Eyes bare; black; bulging out prominently, and extending back to the prothorax. Rostrum black, long-conical; twice as long as the head from which it gradually tapers; sparsely covered with light hairs; supra-clypeal piece just below the antennal cavities; maxilla with horny base, bearing six, short, transverse spines, serrate-spinose apically; maxillary palpi four-jointed, reaching beyond tip of beak; covered with long, light hairs, except last joint, which is the longest and slightly thicker than the others, long-ovate, bare. Labrum flat, more than four times as wide as long, but somewhat constricted in middle; labial palpi one-jointed, with a tuft of hair at tip. Mandibles bidentate, and rather sharp. Prothorax wider than long; coarsely, transversely striate; with an oblique groove extending from each anterior angle and meeting medially near the posterior border to form one, continuous, broad, U-shaped groove; a row of long, black hairs on both anterior and posterior margins. Mesothorax narrow, pubescent. Metathorax as long as prothorax; divided into three parts by two, deep, transverse grooves, which extend down the sides to the coxæ; middle portion much narrowed, allowing the small, round, first abdominal segment to protrude. Abdomen consisting of eight segments, tapering so that the last forms a part of the ovipositor; oval; segments distinctly marked by strongly impressed, transverse lines; the first segment small and partly hidden by the metathorax; all segments densely covered with fine, white, appressed hairs, especially behind. Ovipositor 0.8–1.0 mm. in length; composed of three segments, the middle piece the largest; brilliant black; sheathing style issuing from the seventh abdominal segment, shorter than the ovipositor; finely serrated on its apical third. Legs extremely long and slender, densely clothed with minute hairs; front legs as long as abdomen and ovipositor together, middle legs one and one-third times as long as front legs, and hind legs one and one-third as long as middle legs. Tibiæ with a pair of short spines at tips; posterior half of tibiæ and all tarsal segments with small, short spines. Tarsi five-jointed, the first joint as long as the next three, the second as long as the third and fourth together; the fifth terminated by a pair of small, slender, simple claws. Front wings merely scales; less than 0.2 mm. long and about as wide, with a median longitudinal ridge; tuberculate and set with very

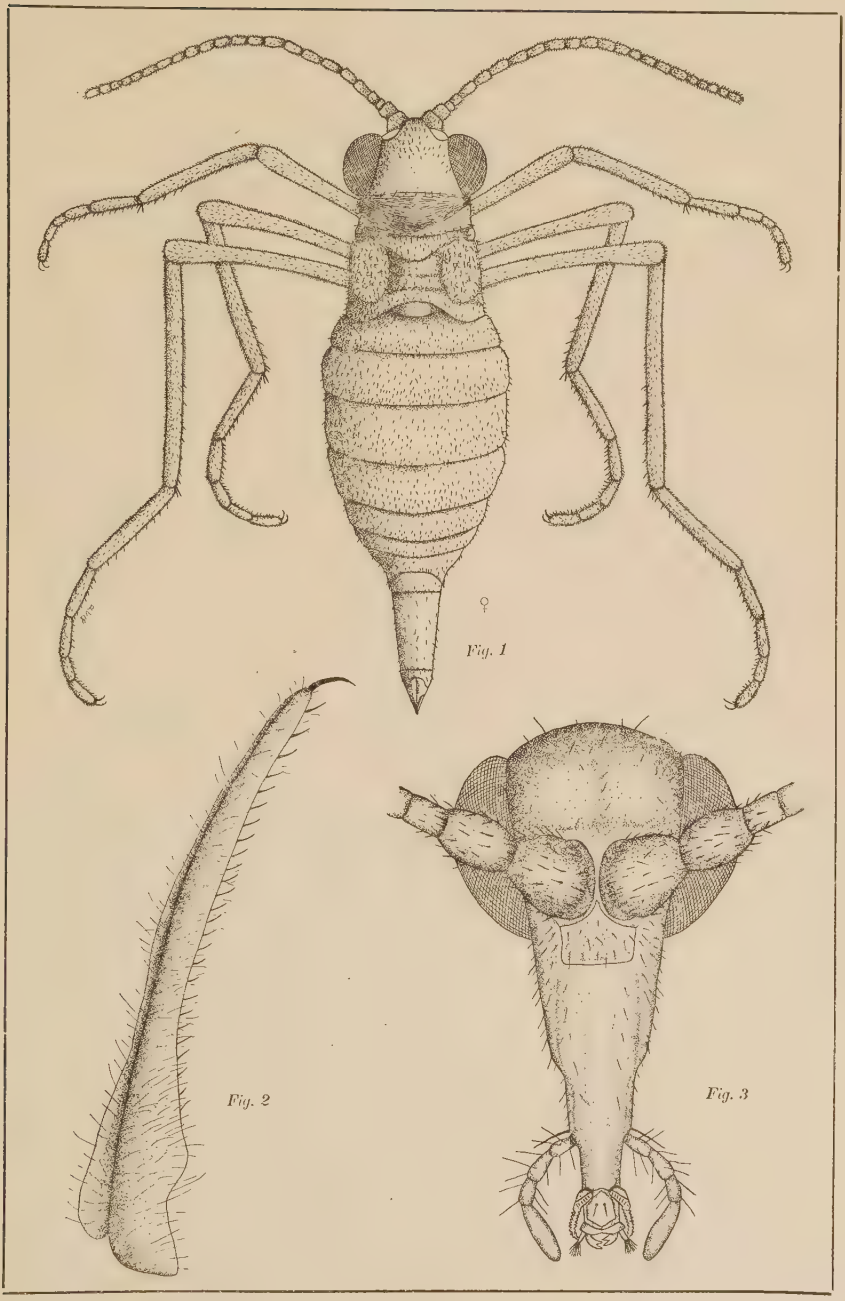

Fig. 1

Fig. 2

Fig. 3

DOHANIAN—*Boreus*.

short, erect hairs; hind wings degenerated into microscopic dots of the same shape as fore wings.

Male. Length 2.50–2.85 mm. Antennæ 23-, sometimes 24-jointed. Front wings 1.7 mm. long, 0.4 mm. wide at base when laid open flat; coriaceous; gradually narrowing toward the tip from which there issues a long, thorn-like spine; upper surface metallic, lustrous, sparsely pubescent; prominent spines issue from both sides of the trough-shaped wing into which the long, slender, chitinous hind wing fits snugly. Hind wing almost a bristle, its extremely sharp tip scarcely projecting beyond that of the fore wing; underside with a thick row of white, woolly pubescence; upper surface glabrous. Abdomen cylindrical, comparatively broader than in the female; the last four segments crowded dorsally and broadened ventrally so as to allow the genitalia to recurve upon the back, and the two prominent, stout, sharp-pointed hooks, each with an acute tooth in the middle of its inner edge and pilose along the outer edge, to point toward the head.

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EXPLANATION OF PLATE 9.

Boreus brumalis Fitch.

Fig. 1. Dorsal view, female.
Fig. 2. Wing of male.
Fig. 3. Front view of head.

SYSTEMATIC PAPERS ON NEW ENGLAND HEMIPTERA

II. SYNOPSIS OF THE PENTATOMIDÆ

By H. M. PARSHLEY

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SYSTEMATIC PAPERS ON NEW ENGLAND HEMIPTERA.[1]

II. Synopsis of the Pentatomidæ.[2]

By H. M. Parshley.

With Plate XVI.

Family PENTATOMIDÆ.

1. First segment of the rostrum largely free, relatively short and thick; bucculæ small, more or less distinctly united under the rostrum posteriorly, hence converging; insertion of rostrum close to end of tylus (fig. 4)

4. ASOPINÆ.

First segment of rostrum largely embedded between the bucculæ, relatively slender; bucculæ large, not united posteriorly, hence more or less parallel; insertion of rostrum separated from end of tylus by a space about equal to width of basal segment (fig. 1) *Pentatominæ* Kirk 2

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 98.

[2] I have found the following works, among others, to be of especial assistance in the study of this family:

Stal: Enum. Hem. I., K. Sv. Vet.-Ak. Handl. IX., 1870. Oef. K. Vet.-Ak. Förh., XXIV., No. 7, 1867, p. 522.

Van Duzee: List. Pent. N. Am., Tr. Am. Ent. Soc. XXX., 1904, p. 1. Can. Ent., XLI., 1909, p. 369, and other papers.

Kirkaldy: Cat. Hem. I., 1909, and other papers.

Heymons: Beitr. Morph. u. Entw. Rhynch. Nova Acta Ac. Leop. Carol. LXXIV., 1899.

Summers: Pr. Iowa Ac. Sci., VI., 1908, p. 40.

Bergroth: Ann. Soc. Ent. Belg., LVIII., 1914, p. 24. Ent. News, XVIII., 1907, p. 48, and other papers.

Breddin: Beitr. Sys. Pent. Südam., Sitz. Ges. Nat. Fr., 10, 1907, p. 328.

Schouteden: Gen. Ins., Het., 1905–1907.

Torre Bueno: Ent. News, XXIII, 1912, p. 316.

Correction: Psyche, June, 1915, p. 93, in the description of the Pentatomidæ the tarsi should be given as 2- or 3-segmented.

2. Tarsi 2-segmented; sternum with a distinct longitudinal keel; frena[1] extending almost to end of scutellum.....3. ACANTHOSOMATINÆ
Tarsi 3-segmented; sternum without keel; frena shorter.....3

3. Scutellum large, broad at apex, extending farther posteriorly than the corium; frena very short; sides of the pronotum with a single prominent tooth just anterior to lateral angle, the angles thus emarginate
1. GRAPHOSOMATINÆ
Scutellum smaller, more or less narrowed apically, generally shorter than the corium; frena longer; pronotum with numerous teeth or with no tooth near lateral angle.....2. PENTATOMINÆ[2]

1. Subfamily GRAPHOSOMATINÆ.

Tribe Podopini.

Genus Podops Lapoŕte.

Size larger, length about 6.5 mm.; 2d, 3d, and 4th segments of antennæ darker; lateral tooth of pronotum obtuse; color very dark brown....c'nctipes Say.
Size smaller, length 5 mm.; 2d, 3d, and 4th segments of antennæ paler; lateral tooth of pronotum acute; color as in the preceding.....parvula V. D.

2. Subfamily PENTATOMINÆ.

1. Body very flat, margins explanate; head with thin dilated margin, about as wide as base of scutellum, flat above; scutellum broad, scarcely narrowed apically (fig. 5) .....1. Sciocorini
Body not extremely flat and explanate; head not very widely dilated, when nearly as wide as base of scutellum head is distinctly convex above, usually narrower than scutellum.....2

2. Juga with a prominent lateral tooth near apex (fig. 3); abdomen shallowly sulcate beneath; rostrum extending behind posterior coxæ.....2. Halyini
Juga without lateral tooth (fig. 6); abdomen not sulcate; rostrum shorter
3. Pentatomini

1. Tribe Sciocorini.

Genus Sciocoris Fallén.

Color brown, connexivum[3] spotted; length 6.5 mm (fig. 5).[4] microphthalmus Flor.

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[1] The frena are longitudinal grooves in the edges of the scutellum which receive the inner margins of the hemielytra. They end about where the clavus disappears beneath the scutellum.

[2] In the latest general catalogue (Kirkaldy, 1909) the Acanthosomatinæ and Graphosomatinæ are given as tribes of the Pentatominæ. This matter is still open to discussion, I believe, but in the present series I plan to follow the check-list of Van Duzee, to whom I am again indebted for advance information.

[3] The marginal region of the abdomen. There are very few records of the occurrence of *Sciocoris* in this country, and collectors should be on the watch for it.

[4] The ocelli in this species are very small and unfortunately do not show in the figure.

2. Tribe Halyini.

Genus **Brochymena** Amyot et Serville.

1. Lateral angles of thorax distinctly produced in a short truncated dentate lobe, not rounded anteriorly; scutellum with a distinct transverse elevation at base; connexivum very wide; color indistinctly mottled grayish brown; length 14–16 mm. ..... **arborea** Say.
   Lateral processes less abrupt, rounded anteriorly, finely denticulate; scutellum less strongly elevated at base 2
2. Juga extending much beyond apex of tylus, contiguous anteriorly, or separated, thus forming a long narrow apical sinus; connexivum moderately wide; color as in the preceding; length 15–17 mm. ..... **quadripustulata** Fab.
   Juga extending but little beyond apex of tylus, tips more or less convergent above, forming a short, sometimes transverse sinus; connexivum narrow; markings more contrasted; length 13–17 mm.
   carolinensis Westw. or **annulata** Fab

3. Tribe Pentatomini.

1. Head very convex above, triangular, almost as broad as scutellum; juga distinctly longer than tylus; apex of corium broadly rounded 2
   Head more nearly flat above, narrower; juga often not longer than tylus; apex of corium generally with a distinct, but sometimes rounded angle; if juga are longer than tylus, or apex of corium is broadly rounded, head is not more than two-thirds width of scutellum 3
2. Anterior angles of pronotum projecting distinctly forward; pronotum with three longitudinal pale stripes ..... 10. **Aelia**
   Anterior angles not so projecting; pronotum with one stripe .. 11. **Neottiglossa**
3. Base of abdomen armed below with a median spine or tubercle, directed anteriorly 17
   Base of abdomen unarmed 4
4. Lateral margins of juga widely reflexed and greatly thickened; orifices placed a little farther outward than lateral margin of intermediate coxal cavities, not elevated; front of head almost vertical ..... 15. **Murgantia**
   Lateral margins of juga not or only narrowly reflexed, not greatly thickened; orifices and head usually otherwise constructed 5
5. Scutellum broad and rounded at apex, lateral margins almost straight; head strongly bent downwards ..... 12. **Cosmopepla**
   Scutellum generally narrowed at apex, lateral margins concave (as in fig. 2); head not or slightly bent downwards 6
6. Orifices without sulcus, or with sulcus which ends abruptly 7
   Orifices with a gradually disappearing prolongation 14
7. Veins of membrane irregularly anastomosing or with numerous branches more or less distinct 8
   Veins simple or slightly branched 10
8. Scutellum broadly rounded at apex, as long as corium; apical margin of corium rounded, apical lateral angle obtuse ..... 8. **Cœnus**
   Scutellum narrowed at apex, shorter than corium; apical margin straight, apical lateral angle acute 9

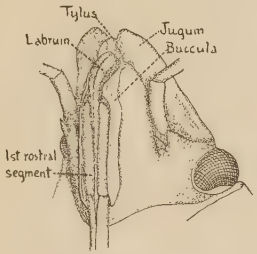

Fig. 1. Ventral view of head of Rhytidolomia senilis.

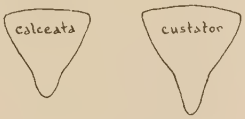

Fig. 2. Scutella of Thyanta. After Barber

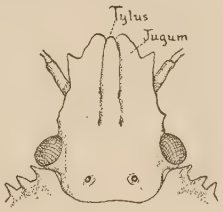

Fig. 3. Head of Brochymena arborea.

Fig. 4. Ventral view of head of Apateticus bracteatus.

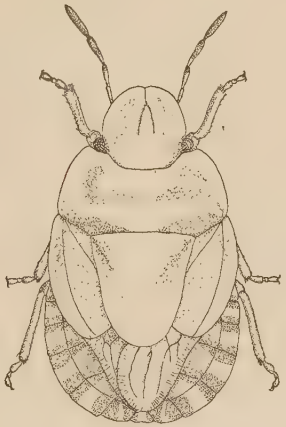

Fig. 5. Sciocoris microphthalmus.

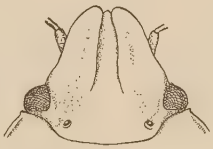

Fig. 6. Head of Rhytidolomia senilis

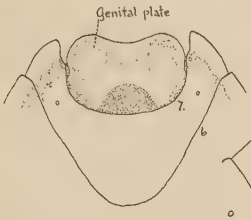

Fig. 7. External genitalia of Euschistus variolarius ♂.

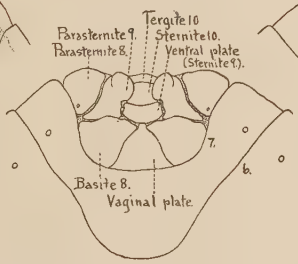

Fig. 8. External genitalia of Apateticus bracteatus ♀

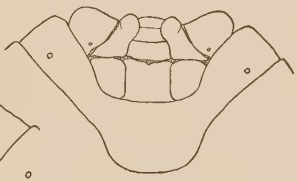

Fig. 9. External genitalia of Apateticus cynicus ♀.

9. Frena extending just to middle of scutellum; bucculæ increasing in height posteriorly, ending abruptly; lateral margin of pronotum not explanate; rostrum extending a little beyond intermediate coxæ.....9. **Hymenarcys**
Frena extending beyond middle of scutellum; bucculæ decreasing in height posteriorly, elevated anteriorly into an angle; lateral margin of pronotum explanate in front; rostrum extending beyond intermediate coxæ 13. **Menecles.**
10. Frena extending beyond middle of scutellum.....11
Frena shorter .....2. **Trichopepla**
11. Tibiæ distinctly and broadly sulcate throughout their length.....12
Tibiæ not so sulcate.....14
12. Lateral margins of pronotum crenulate, lateral angles prominent, rounded or acuminate; head rather elongate.....7. **Euschistus**
Lateral margins of pronotum not crenulate, lateral angles not prominent; head shorter.....13
13. Form elongate; color olivaceous green; second and third segments of rostrum nearly equal, fourth shorter.....4. **Rhytidolomia**
Form broad; color clear green; second segment of rostrum longer than third, third nearly equal to fourth.....3. **Chlorochroa**
14. Thorax armed on each side with a long anteriorly projecting spine; first segment of rostrum shorter than bucculæ; form elongated; margin of scutellum concolorous.....6. **Solubea.**
Thorax unarmed; first segment of rostrum longer than buccalæ; form broad; scutellum outlined with white.....5. **Mormidea**
15. Juga not longer than tylus.....14. **Thyanta**
Juga longer than tylus, almost or quite contiguous in front (somewhat as in fig. 5).....16
16. Prothorax with conspicuous white impunctate margins extending around lateral angles.....1. **Peribalus**
Prothorax without such margins, impunctate anteriorly only 19. **Dendrocoris**
17. Fifth antennal segment more than twice the length of second; apex of scutellum and anterior region of prothorax lighter; species olivaceous green in color 18. **Banasa**
Fifth antennal segment less than twice length of second; scutellum and prothorax concolorous; species clear green in color.....18
18. Orifices short, rather broad, not extending more than half way to lateral margins of metapleura, ending abruptly.....17. **Nezara**
Orifices continued in a long narrowing ruga, extending almost to posterior lateral angles of mesopleura.....16. **Acrosternum**

1. Genus **Peribalus** Mulsant et Rey.

Holcostethus Kirk. in part.

Color brown, tip of scutellum and margins of body more or less pale; length 7.5–9 mm.....**limbolarius** Stal.

2. Genus **Trichopepla** Stal.

Color brown with faint paler markings; connexivum spotted; body pilose; length 6.5–8 mm.....**semivittata** Say.

3. Genus **Chlorochroa** Stal.

Pentatoma Auct. in part.
Rhytidolomia Kirk, in part.

Color green, margins of body and tip of scutellum reddish yellow; length 12–14 mm. **uhleri** Stal or **persimilis** Horv.[1]

4. Genus **Rhytidolomia** Stal

Pentatoma Auct. in part.

Larger, length 16 mm.; lateral margins of pronotum narrowly reflexed (fig. 6) color dark olive brown, the margins paler ..... **senilis** Say.
Smaller, length 9.5–11 mm., pronotal margins not reflexed; color dark olive, with median and lateral pale stripes ..... **saucia** Say.

5. Genus **Mormidea** Amyot et Serville.

Color dark brown, pronotum with two transverse pale stripes, lateral margins of scutellum and edges of connexivum pale; length 6 mm. ..... **lugens** Fab.

6. Genus **Solubea** Bergroth.

Oebalus Stal.

Color light brown, scutellum and markings of head paler; length 8–10 mm. **pugnax** Fab.

7. Genus **Euschistus** Dallas.

1. Pronotum with a distinct more or less impunctate raised line running transversely between the lateral angles; pronotum distinctly wider than the abdomen; juga generally somewhat longer than the tylus; color variable, generally some shade of brown throughout the genus; length about 11 mm. **ictericus** Linn.

   Pronotum without such a line, proportionately narrower 2
2. Juga distinctly longer than the tylus, apex of head thus emarginate; hemielytra covering the connexivum; length 12–15 mm. **fissilis** Uhl. or **euschistoides** Voll.

   Juga not or very slightly longer than the tylus, apex of head thus rounded or truncate 3
3. Lateral angles of the ventral abdominal segments concolorous; genital plate of the male with a dark spot (fig. 7); form somewhat narrowed posteriorly; length about 13 mm. ..... **variolarius** Pal. Beauv.

   Lateral angles of the ventral segments with a black dot; hemielytra generally not covering the connexivum 4
4. Smaller, length 8–9 mm., form rather flattened; lateral margins of pronotum pale and somewhat swollen, the closely set marginal punctures forming a distinct black band ..... **politus** Uhl.

   Larger, length 10 mm. or more; form more convex 5
5. Larger, length 12–15 mm; abdomen without a median ventral row of black spots **servus** Say.

   Smaller, length 10–12 mm.; abdomen usually with a median ventral row of black spots more or less developed ..... **tristigmus** Say.

[1] These forms are considered identical by Van Duzee.

8. Genus Cœnus Dallas.

Color brown, finely dotted with black; length about 8 mm. . . . . **delius** Say.

9. Genus **Hymenarcys** Amyot et Serville.

Lateral margins of pronotum arcuate; larger, length 9 mm.; color dark brown
nervosa Say.

Laterals margins of pronotum straight; smaller, length 7.5 mm.; color about as in preceding . . . . . *æqualis Say.[1]

10. Genus **Aelia** Fabricus.

Color light brown with longitudinal pale stripes; length 8 mm. . . . *americana Dallas

11. Genus **Neottiglossa** Kirby.

Color brown with rather faint pale markings; length about 5 mm. . . . . **undata** Say.

12. Genus **Cosmopepla** Stal.

Color black with red markings; length about 5 mm.
lintneriana Kirk. or **carnifex** Fab.

13. Genus **Menecles** Stal.

Color brown, connexivum spotted; length 13 mm. . . . . **insertus** Say.

14. Genus **Thyanta** Stal.

Scutellum less elongated apically, shorter as a whole (fig. 2); form of body shorter and broader; colors constant, dark green, prothorax narrowly black laterally, and with a distinct purplish transverse band between the lateral angles; length about 9 mm. . . . . **calceata** Say.[2]

Scutellum more elongated apically, longer as a whole (fig. 2); general form more elongated; colors variable, very light to dark green, transverse band of pronotum more or less distinct; length about 11 mm. . . . . **custator** Fab.[2]

15. Genus **Murgantia** Stal.

Color black, variegated with red; length 10 mm. . . . . **histrionica** Hahn.

16. Genus **Acrosternum** Fieber.

Nezara Kirk. in part.

Form broadly oval; sides of pronotum arcuate anteriorly; rostrum scarcely reaching intermediate coxæ; color shining clear green; length about 17 mm.
pen(n)sylvanicum (de G.) Pal. Beauv.

Form more elongate; sides of pronotum straight anteriorly; rostrum reaching intermediate coxæ; color and size about as in preceding . . . . . **hilare** Say.

17. Genus **Nezara** Amyot et Serville.

Color dull green; length about 16 mm. . . . . *viridula Linn.

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[1] Asterisk marks species not known to occur in New England. Dagger marks species which I have not seen.

[2] For further details regarding these species and figures of the male genitalia, see Barber: Jour. N. Y. Ent. Soc., XIX., 1911, p. 9.

18. Genus **Banasa** Stal.

1. Posterior lateral angles of abdominal segments acuminate, projecting somewhat; color brownish; 10 mm. ..... **sordida** Uhl.
   Posterior lateral angles obtuse, not very prominent 2
2. Third antennal segment about twice as long as second; head broad anteriorly; margin of abdomen with conspicuous black dots at the angles of the segments; color greenish with olivaceous markings; length 7.5–11 mm. . . **dimi(di)ata** Say.
   Third antennal segment but little longer than the second; head narrowed anteriorly; margin of abdomen with conspicuous black dots; ventral abdominal punctures fewer and paler; genital plate of male narrower; colors somewhat paler; length 9–11 mm. ..... **calva** Say.

19. Genus **Dendrocoris** Bergroth.

Color brown, with paler areas of variable extent, connexivum spotted; length 6.5–7.5 mm. ..... **humeralis** Uhl.

3. Subfamily ACANTHOSOMATINÆ.

Lateral angles of pronotum emarginate; posterior lateral margins depressed; orifices abruptly curved, short ..... 1. **Elasmucha.**
Lateral angles entire; posterior lateral margins not depressed; orifices nearly straight, longer ..... 2. **Elasmostethus**

1. Genus **Elasmucha** Stal.

Color yellowish brown, mottled with reddish, variable in shade; length 7–9 mm. **lateralis** Say.

2. Genus **Elasmostethus** Fieber.

1. Antennæ black or dark brown; punctures of pronotum concolorous except along posterior margin; color pale yellowish with reddish markings; length 10 mm. ***atricornis** V. D.
   Antennæ pale; pronotal punctures dark 2
2. Larger, length 10 mm.; pronotum broader and shorter; color greenish yellow with reddish markings ..... **cruciatus** Say.
   Smaller, length 8 mm.; pronotum narrower and longer; colors as in preceding †***cooleyi** V. D.

4. Subfamily ASOPINÆ.

Arminæ Bergr.

Cimicinæ Kirk.

1. Anterior femora armed with a spine or prominent tubercle near apex 2
   Anterior femora unarmed 3
2. Scutellum large, broad, extending almost or quite to end of abdomen; frena not over one-third the length of the scutellum ..... 6. **Stiretrus**
   Scutellum moderate in size, attenuated apically; frena extending to middle of scutellum ..... 1. **Perillus.**
3. Base of abdomen armed below with a spine or tubercle 4
   Base of abdomen unarmed ..... 3. **Zicrona**

4. Frena extending beyond middle of scutellum; bucculæ slightly elevated, disappearing posteriorly.....5
Frena extending to middle of scutellum; bucculæ distinctly elevated, not thinning out posteriorly; male with two patches of silken pubescence on the abdomen below.....2. **Mineus**
5. Larger, length usually over 13 mm.; tylus generally shorter than juga, apex of head thus emarginate.....4. **Apateticus**
Smaller, length usually less than 13 mm.; tylus as long as juga, apex of head thus truncate.....5. **Podisus**

1. Genus **Perillus** Stal.

Perilloides Schouteden.

Anterior femora armed with a low conical tubercle; color entirely black, or black with red or yellowish markings; length 5–7 mm.....**exaptus** Say.
Anterior femora armed with a more or less cylindrical blunt spine; color brown with pale yellowish markings; length 8–10 mm.....**circumcinctus** Stal.

2. Genus **Mineus** Stal.

Color bluish black with red markings; length 8 mm.....**strigipes** H. S.

3. Genus **Zicrona** Amyot et Serville.

Color iridescent greenish blue; length 6 mm.....**cærulea** Linn.

4. Genus **Apateticus** Dallas.

Vaginal plate of the female genitalia triangular (fig. 8); pronotal spines shorter and less acute; anterior lateral margins of pronotum more distinctly serrulate; color brown; length 13–18 mm.....**bracteatus** Fitch.
Vaginal plate quadrangular (fig. 9); pronotal spines longer and more acute; anterior lateral margins of pronotum very finely serrulate; color as in the preceding; length 16–20 mm.....**cynicus** Say.

5. Genus **Podisus** Herrich-Schæffer.

1. Lateral angles of pronotum blunt, projecting but little; membrane without a dark longitudinal stripe; color mottled brown; length 9–11 mm.. **placidus** Uhl.
Lateral angles distinctly projecting, more or less spine-like; membrane with a dark longitudinal stripe.....2
2. Color usually reddish brown; basal spine of abdomen short, not extending between hind coxæ; lateral angles of pronotum rather blunt.....3
Color grayish brown; basal spine of abdomen long, extending between hind coxæ; lateral angles acute; length 10–12.5 mm.....**maculiventris** Say.
3. Smaller, length 7–8 mm.; form narrow; second antennal segment one-fourth longer than the third; color pale reddish brown.....**modestus** Dallas.
Larger, length 8–10 mm.; form wider; second antennal segment one-third longer than the third; color darker.....**serieventris** Uhl.

6. Genus **Stiretrus** Laporte.

Color very variable, green with white or yellowish markings in New England specimens, blue and red in various combinations in forms from other regions; length about 9 mm.....**anchorago** Fab.

SOME NEW PHORIDÆ FROM JAVA.

[Reprinted from JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, Vol XXIII, No. 3, September, 1915.]

SOME NEW PHORIDÆ FROM JAVA.[1]

BY CHARLES T. BRUES,

FOREST HILLS, MASS.

Some time ago I received through the courtesy of Professor J. C. H. de Meijere a collection of Javanese Phoridæ belonging to the Amsterdam Museum. These were collected mainly by Mr. E. Jacobson who has made some interesting observations on certain members of this family in Java.

A number of new species are included in the lot which are described in the present paper.

Dohrniphora egregia Brues.

Ann. Mus. Nat. Hungarici, vol. 9, p. 534 (1911).

Of this species originally described from Formosa, there is a single specimen from Nongkodjadjar, Java, January (Jacobson).

Hypocera flavidula new species.

Male.—Length 2 m. Light yellowish brown; front piceous; abdominal segments three to six black, the sides of the first and second darkened; wings distinctly infuscated, especially near the anterior border. Front small, scarcely wider than the eye when seen from above, nearly quadrate; bristles not very strong; post-antennal pair close together, at the extreme anterior margin of the front; next row above of four bristles forming a line that is strongly

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 99.

bowed downwards medially, the median bristles twice as far from each other as from the lateral ones which are well removed from the eye margin; bristles of next row just above the corresponding ones of the row below, but the row is not so strongly bowed downwards medially; ocelli on an elevated black area which is semicircularly raised above the upper margin of the front. Antennæ orange-colored, moderately large; almost spherical, but somewhat pointed at tip; arista very weakly pubescent, a little longer than the head-height. Palpi scarcely paler than the antennæ, stout, but not enlarged; bristly only at the apex, the bristles not strong. Postocular cilia large, except near the vertex; cheeks each with two long bristles, one of which is much stouter than the other. Mesonotum broad, strongly bristly along its lateral margin; one pair of dorsocentral macrochætæ placed nearer the hind angles than usual. Scutellum very short, nearly four times as broad as long, with four large bristles set very far from the median line. Propleura with three small bristles just above the insertion of the anterior coxa; mesopleura clothed with sparse black hairs anteriorly and above. Abdomen subshining; sixth segment elongated; hypopygium more or less globose, shining yellow, clothed below with sparse bristly black hairs as is also the sixth segment behind; hypopygial lamellæ finely bristly, apical bristles not enlarged. Legs slender, none of the femora thickened; anterior tibiæ with a short bristle externally at the basal fourth, another at the basal third, and another at the middle followed by four or five which become extremely minute before the apex, no spurs; middle tibiæ with a small bristle behind the outer edge near the base, another in front of the edge at the basal fourth, another in front at the middle, a series of three minute ones on the edge near the apex, and three series of minute comb-like bristles in front of the edge near apex, one long spur; posterior tibiæ with a series of six or seven small bristles outside the hind edge and two short spurs. Wings long and narrow; costal vein extending barely beyond the middle, with extremely minute, closely placed, hair-like bristles; first vein ending four times as far from the humeral cross-vein as from the tip of the third; fourth very near the costal margin of the wing, nearly straight except near apex, and recurved at both base and apex, fifth faintly sinuate; sixth more distinctly so; seventh not very distinct. Halteres concolorous with the thorax.

Three specimens from Samarang, March and November, and Batavia, Java, December (Jacobson).

A very distinct species by its color and wing venation. The color of the abdomen varies somewhat, the segments may be quite distinctly margined with pale yellow and the black on the basal segments sometimes extends inwards for a considerable distance.

APHIOCHÆTA Brues.

There are four undescribed species which may be separated by the aid of the following key:

1. Bristles of hind tibiæ in a single series, inside the hind edge 2
   Bristles of hind tibiæ in two series, a stronger one inside the hind edge and a weaker one just outside the hind edge; fore metatarsi of male enlarged, as thick as their tibiæ .....*A. fortiuscula* n. sp.
2. Mesopleura bare 3
   Mesopleura with a number of small bristles above, near the root of the wing .....*A. canaliculata* n. sp.
3. Body black, first costal division much longer than the second..*A. atrita* n. sp.
   Head, thorax and legs yellow; first costal division as long as the second *A. meijerei* n. sp.

Aphiochæta fortiuscula new species. Pl. XIII, fig. 1.

Male.—Length 2–2.5 mm. Thorax brownish-yellow; legs testaceous, with the hind femora infuscated at apex; head black; antennæ dull ferruginous; palpi testaceous; abdomen black, first segment yellow; with narrow, clearly defined yellowish apical bands on all the other segments, each segment medially with a yellowish brown spot near the anterior margin; wings tinged with brownish, the veins fuscous. Front one third higher than broad, brownish along its lower margin; with ocellar tubercle and median frontal line, its bristles large and strong; surface subopaque, pollinose; four post-antennal bristles, the median ones nearly as large as the outer ones and two-thirds as far apart; outer ones slightly nearer to the median line than to the eye-margin and placed higher up than the inner pair of the next row above which are well below the outer bristles of this row; bristles of middle frontal row equidistant, forming a line that curves downward medially. Eyes strongly pubescent. Antennæ small, arista pubescent, twice as long as the front. Palpi of moderate size, strongly bristled below. Postocular cilia enlarged near the upper third of the eye; cheeks below each with a strong bristle and a series of gradually smaller bristles extending to the base of the antenna. Mesonotum elongate, quite shining, with five bristles along the lateral margin; one pair of dorsocentral bristles. Scutellum twice as broad as long, with two strong marginal bristles, the outer pair represented only by hairs. Propleura sparsely hairy, with two bristles at the base of the coxæ and several at the humeri; mesopleura finely bristly above, and with two large, backwardly directed bristles. None of the abdominal segments elongated; each segment with a marginal line of short bristly hairs which also extend forward on the sides of the second and third segments; sixth covered with similar hairs. Genitalia visible only as a pale yellow lamella which bears two bristly hairs at tip. Legs rather stout and short. Fore tibiæ with a singe series of about 12 distinct setulæ nearly half as long as the width of the tibia; middle tibiæ with setulæ in a double row of about eight each, nearly as long as the width of the tibia, and one long spur; hind tibiæ with a row of ten long setulæ inside the hind margin and a row of eleven smaller ones on the basal two thirds outside

the hind margin; with one long and several short spurs. Fore metatarsi three-fourths as long as the tibia and almost as thick near the base, one fourth as thick as long; second tarsal joint twice as long as broad and nearly as long as the metatarsus; following joints also distinctly thickened, wings long and slender, especially toward apex; costal vein extending to the middle of the wing, its bristles short and closely placed; first costal division one half longer than the second; third one-third as long as the second, the furcation of the third vein acute; fourth vein curved near base, and straight beyond; fifth and sixth sinuate, nearly straight; seventh distinct, nearly straight. Halteres dull, light yellow, infuscated on the apex of the knob.

Two males, Depok, Java, October, 1909, and Samarang, Java, June, 1909 (Jacobson).

This species could not be confused with any others having the fore metatarsi enlarged as it has the hind tibiæ biseriate and neither the antennæ nor palpi are enlarged.

Aphiochæta canaliculata new species. Pl. XIII, fig. 6.

Male.—Length 2 mm. Piceous black, incisures of the legs, front tibiæ and tarsi, and middle tibiæ at apex, light yellow; tip of hind tibiæ and the middle and hind tarsi deeper yellow; palpi dull yellow; hypopygial lamella yellow. Wings tinged with brownish, veins piceous. Front slightly broader than high, its surface slightly pollinose but shining. Frontal bristles very long and well developed; ocellar tubercle and median frontal groove present; four post-antennal bristles of nearly uniform size, the lower ones two-thirds as far from the median line as the upper; inner bristle of next row on a level with the lower post-antennal bristle, outer one level with the upper post-an-antennal; four equidistant bristles in next row, forming a line curving downward medially. Postocular cilia large and stout; cheeks with two or three stout bristles followed by a series of smaller ones extending to the base of the antennæ. Antennæ slightly enlarged, the arista distinctly pubescent, slightly over twice as long as the height of the front. Palpi stout, slightly swollen, with very strong bristles near the apex. Mesonotum shining, its lateral bristles weak, about five in number; no dorsocentral bristles although there is a strong bristle at each posterior angle and a row of six bristly hairs near the base of the scutellum. Scutellum almost semicircular, with two long marginal bristles. Propleura shining, bare, except for five or six rather strong upwardly directed bristles near the spiracle and three strong downwardly directed ones just above the insertion of the coxa; mesopeura above with a patch of about eight coarse, bristly hairs. Abdomen with the second and sixth segments very slightly elongated; upper surface sparsely clothed with short, stiff hairs, more abundant at the sides. Hypopygium small, not inflexed, the lamella broad. Legs moderately long and slender, densely hairy; front tibiæ with long hairs externally, but no setulæ, their tarsi slender; middle tibiæ with about six fine setulæ inside the hind edge and an equal number of smaller ones on the basal half outside the edge, one long spur; hind tibiæ with a single row of about a

dozen medium-sized setulæ inside the hind edge from which they are separated by a more distinct groove than usual, one long and one short spur. Hind femora with a few curved bristly hairs below at the base. Wings rather long and narrow, the costa reaching barely beyond the middle of the wing, its bristles rather long, slender and closely placed; first division equal to or scarcely exceeding the second; third one-third as long as the second, the furcation of the third vein acute; fourth vein curved only at the base; fifth vein nearly straight, sixth slightly sinuate, seventh distinct. Halteres piceous, yellowish at the base of the knob.

One male from Goenceng Gedeh, Java, March, 1911 (Jacobson). This is related to the British *A. beckeri* Wood, from which it differs by the small hypopygium, shorter costal bristles and higher front.

Aphiochæta atrita new species.

Male.—Length 2 mm. Black; legs piceous, the front pair fuscous; wings hyaline, veins dark fuscous; palpi pale yellow. Front about as high as broad, its bristles strong; ocellar tubercle and median frontal groove present; four post-antennal bristles, the lower ones half the size of the upper and two-thirds as far apart; inner bristles of next row barely above the upper post-antennals and midway between them and the eye-margin; outer bristles of this row close to the eye-margin and considerably above the inner ones; row above strongly curved downward medially. Antennæ rather large; arista pubescent, one-half longer than the height of the front. Palpi of moderate size, strongly bristly below. Cheeks each with two large, stout bristles directed downwards and a series of much smaller ones extending toward the base of the antennæ. Mesonotum strongly convex, subshining, its lateral bristles short, except for one very long one a short distance in front of the hind angle; one pair of distinct dorsocentral bristles. Scutellum twice as broad as long, not strongly curved behind, with one pair of strong bristles and a weak hair anterior to each of these. Propleura bare except for three downwardly directed bristles at the lower margin and one upwardly directed one just below the spiracle. Mesopleura bare, shining below and slightly roughened above. Abdomen bare except for a few bristles on the last two segments and a very few short ones evenly distributed along the sides; none of the segments elongated. Hypopygium very small, sparsely clothed with fine hairs; lamella dark, paler at tip. Legs long, but rather stout; front tibiæ without setulæ, their tarsi slender; middle tibiæ with no distinct setulæ and one long spur; hind tibiæ with a few weak and rather short setulæ inside the hind margin on the apical two thirds, with one moderate and one short spur; hind femora with a few weak curved bristly hairs below near the base. Wings moderately long and narrow; costa just attaining the middle of the wing, its bristles of medium length and sparsely placed apically although closer together near the base; first section of costa barely longer than the second and third together; second twice as long as the third; fourth vein weakly curved at the base, almost straight beyond; fifth

and sixth very faintly sinuate; seventh faint, straight, parallel with the sixth and well removed from the anal angle of the wing. Halteres entirely black.

One specimen from Goenceng Gedeh, Java, March 11 (Jacobson).

The hypopygium is so small and the lamella so broadly attached at the base that I was at first in doubt as to the sex of the type. The two upcurved bristles at the apex of the appendage and the absence of an ovipositor of any type hitherto described, make it evident that the individual is a male.

Aphiochæta meijerei new species. Pl. XIII, fig. 7.

Male.—Length 2.5 mm. Pale yellow; ocellar tubercle, knob of halteres, an oblique spot at each side of the first abdominal segment; third, fourth and fifth abdominal segments, except a median band which extends laterally along the sutures, seventh segment, and apex of hind femora black. Wings tinged with yellow, especially in front; veins brownish yellow. Front as broad as high, with ocellar tubercle and median frontal groove; four post-antennal bristles, the upper ones one-third longer than the lower ones and nearly twice as far apart; bristles of next row extremely close together near the eye-margin, both below the upper post-antennals; next row of four equidistant bristles forming a row curved downwards medially. Antennæ small; arista pubescent, nearly twice as long as the height of the front. Palpi of moderate size, with very strong bristles toward the tip. Mesonotum subshining, with six bristles along the lateral margin; one pair of dorsocentral bristles. Scutellum nearly semicircular, with one pair of bristles and a weak hair anterior to each of these. Propleura with two downwardly directed bristles below and a patch of hairs forming a double row below the spiracle and extending half way down the pleura; mesopleura entirely bare. Abdomen with the second segment slightly elongated, furnished with a patch of bristles on each side which is repeated on the three following segments. Legs slender; anterior tibiæ without setulæ, their tarsi not enlarged; middle tibiæ with about eight small setulæ inside the hind edge and as many minute ones outside the edge; with one long spur; hind femora slightly ciliated below at base; their tibiæ with ten or a dozen rather small setulæ in a single series. Wings narrow; costal vein slightly exceeding the middle of the wing, its bristles extremely minute and closely placed; first division of costa not quite as long as the second which is five times the length of the third; light veins all very weakly curved, the fourth almost straight except near base and apex. Halteres with piceous knob and yellowish brown pedicel.

One female from Wonosobo, Java, April, 1909 (Jacobson). I have also some specimens from Formosa.

A species very similar to the widespread *A. flava*, but with fewer and larger setulæ on the middle hind tibæ, larger lower post-antennal bristles, and dark halteres.

Aphiochæta gregalis de Meijere. Pl. XIII, fig. 5.

Ann. Jard. Bot. Buitenzorg, 2nd Ser., Suppl. III, p. 931 (1910).

From a specimen of this species determined by de Meijere, I am able to add the following characters to the original description:

The median pair of lowest reclinate frontal bristles equidistant from the median line and the eye-margin and inserted scarcely above the two proclinate ones; the lateral ones of this row small, inserted near the eye margin and a considerable distance above the median ones. Propleura with a number of bristles, longer at the insertion of the coxa; mesopleura above with numerous very fine, delicate bristles, but no large ones. None of the abdominal segments elongated, second with a few bristles at each side; sixth apically and the seventh with a number of fine black bristles. Legs very long (fig. 5).

Phalacrotophora jacobsoni new species.

Male.—Length 3.5 mm. Black; legs beyond the femora brownish-yellow, femora piceous except at base and apex; antennæ orange-yellow, palpi pale yellow; scutellum brown along posterior margin; hypopygial lamella pale yellow; halteres yellowish white; wings subhyaline, slightly infuscated toward apex. Front twice as high as wide, produced anteriorly into a rounded lobe; surface shining, impunctate; only two proclinate bristles, placed close together and well-developed, but much shorter than the two reclinate bristles of the next row above which are placed above the lower margin twice as far from the median line as from the eye-margin; next row consisting of only two medium-sized bristles next the eye-margin at the middle of the front; row above of four equidistant medium-sized bristles which form a line that is slightly, but distinctly bowed upward medially; ocellar row of four bristles; ocelli large, in a low triangle. Vertex raised, carinate on its margin for some distance along the outer orbits, but not set off from the front by a distinct groove. Eyes large, strongly pubescent, their inner margins parallel. Antennæ small, with a dorsal, faintly pubescent arista as long as the head-height. Postocular cilia much lengthened just above the middle of the eye, but smaller again above where they follow the eye-margin inside the raised vertex. Mesonotum elongate, almost twice as long as wide, thickly hairy, but shining; with three long bristles along the lateral margin before the wing, one just behind the root of the wing followed by two very long ones before the hind angle; posterior margin with eight slender bristles overlying the scutellum; no distinct dorsocentral bristles. Scutellum twice as broad as long, with two strong marginal bristles near each lateral angle. Abdomen bare and shining above, with short, bristly hairs along the lateral margin; none of the segments noticeably elongated; hypopygial lamella with two upcurved bristles at apex. Pleuræ smooth, without bristles except for two small ones above the

insertion of the anterior coxa and one at the upper anterior angle of the propleura. Legs short and stout: front coxæ hairy beneath and bristly at tip; middle coxæ hairy, bristly along outer margin, but scarcely so at tip; all tibiæ biseriately setose; setæ of front tibiæ in nine pairs; those of middle tibiæ very stout, longer than the width of the tibia, in eight pairs; those of hind tibiæ scarcely longer than those of the middle ones, in eight pairs, front tibiæ with a circle of small blunt spinules at tip; middle ones with one large and three smaller spurs; hind ones with several moderate sized spurs; all femora very stout, those of the four posterior legs flattened, shortly ciliate below, the hind ones one-third as broad as long. Wings long and narrow; costal vein extending to the middle, with short, fine, closely placed bristles, first vein ending a little further from the humeral cross-vein than from the tip of costa; tip of second vein close to the tip of third, the cell at the furcation small and narrow; fourth vein slightly curved at base, recurved apically; fifth evenly arcuate, except for a slight recurving at base; sixth and seventh nearly straight. Halteres yellowish white.

Female.—Length 4 mm. Fifth abdominal segment with a brownish yellow band at apex; sixth segment piceous, brown laterally in front. Abdomen with the sixth segment elongated.

Described from a male and female taken at Batavia, Java, in August, 1907 (Jacobson).

This species is closely related to *Aphiochæta braunsi* Brues[1] from Cape Colony which also is properly referable to *Phalacrotophora* on account of the extremely long front. It differs from the South African species by the form of the upper row of frontal bristles, lack of distinct dorsocentral bristles, shorter scutellum; short first wing vein and recurved fourth vein. In color and other characters the two species are very similar.

Plastophora javensis new species. Pl. XIII, figs. 2 and 3.

Male.—Length 1 mm. Thorax dull fuscous, head and abdomen piceous; legs dull yellowish, the hind femora darker; and the fore coxæ whitish hyaline, with fuscous thick veins and almost hyaline light veins. Front somewhat more than one-half higher than wide; two very small, proclinate post-antennal bristles; bristles of lowest reclinate row well-developed, the median ones nearer to the median line than to the eye-margin, far below the lateral ones which are quite close to the eye-margin; middle reclinate row equidistant, curving upwards medially; ocellar row large; ocelli on a very indistinctly defined elevation; median frontal line present. Antennæ of moderate size, with apical, bare, arista on the oval third joint; antennal cavities very shallow. Palpi and proboscis injured in the type so that they cannot be described. Postocular cilia large, but not closely placed; two larger bristles on each

[1] Entom. News, Vol. 18, p. 391 (1907).

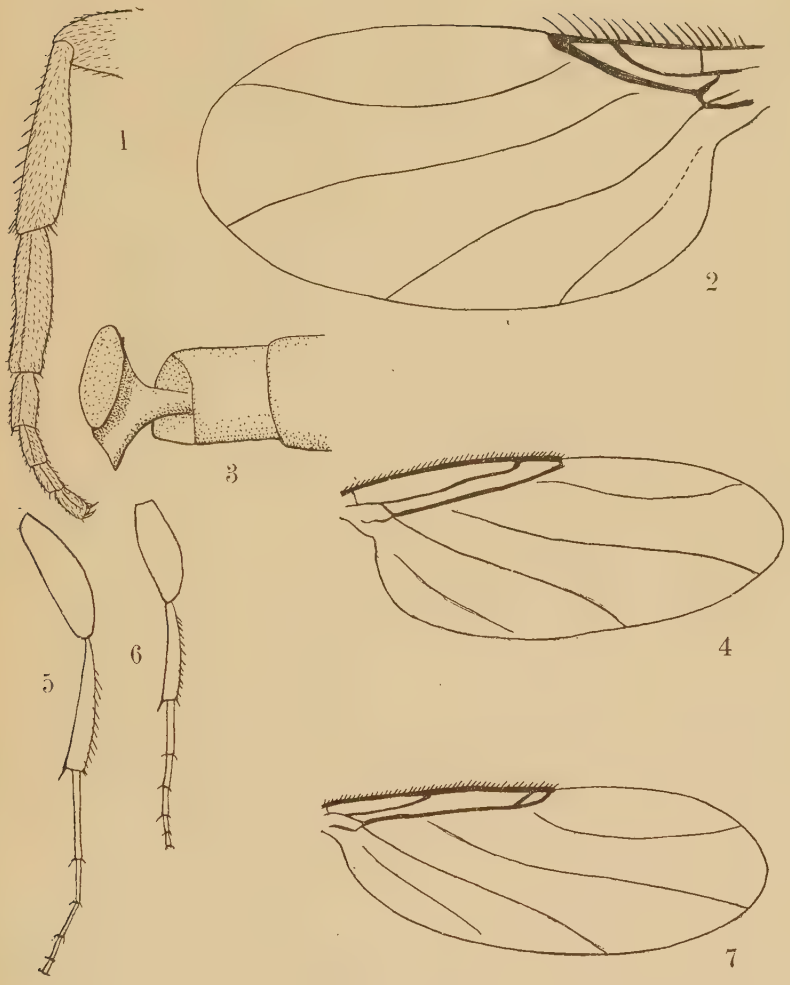
cheek; eyes distinctly pubescent. Mesonotum subshining, clothed with coarser hairs than usual; along each side with three long bristles before the root of the wing and another behind at the lateral angle; one pair of conspicuous dorsocentral bristles, but no bristles along the posterior margin. Scutellum suddenly shortened laterally, with one pair of marginal bristles, although a second lateral pair is indicated by fine hairs. Abdomen opaque; without hairs or bristles; second and sixth segments slightly elongated. Ovipositor chitinized, enlarged apically from a narrowed base and truncate so that the apex is in the form of an oval, margined disk (fig. 3) below which is a downwardly projecting tooth or short blade. Legs long and very slender; fore and middle coxæ with a few bristles at tips. Tibiæ hairy, but without any distinct setulæ; middle ones with a slender, moderately long spur, hind ones with only a very weak and indistinct spur. Propleura with several small bristles at the base of the fore coxa, mesopleura apparently bare. Wings broadly oval; costal vein falling distinctly short of the middle of the wing, with about 14 long, sparsely placed bristles; third vein thickened, not forked; first vein ending close to the third, its tip twice as far from the humeral cross-vein as from the tip of the third; fourth vein evenly curved; fifth and sixth sinuate; seventh nearly straight. Halteres whitish yellow.

One specimen from Samarang, Java, October, 1909 (E. Jacobson). The label bears the additional information "myrmecophilous."

This species is at once distinct by the peculiar configuration of the ovipositor. The very short costal vein is similar to that of the North American species, *P. crawfordi* Coq. and *P. currei* Malloch from both of which the Javanese form differs by its narrower front and the arrangement of the frontal bristles.

EXPLANATION OF PLATE XIII.

Fig. 1. Fore tarsus of *Aphiochæta fortiuscula* n. sp.
Fig. 2. Wing of *Plastophora javensis* n. sp.
Fig. 3. Ovipositor of *Plastophora javensis* n. sp., lat. view.
Fig. 4. Wing of *Hypocera flavidula* n. sp.
Fig. 5. Hind leg of *Aphiochæta gregalis* de Meijere.
Fig. 6. Hind leg of *Aphiochæta canaliculata.*
Fig. 7. Wing of *Aphiochæta meijerei* n. sp.



Phoridæ.

TWO NEW SPECIES OF HISTER.

By F. G. CARNOCHAN.

[Reprinted from Psyche, Vol. XXII, No. 4]

TWO NEW SPECIES OF HISTER.[1]

By F. G. Carnochan.

Hister solaris sp. nov.

Oval, shining, about the size of *Hister furtivus*. Head punctate with frontal stria semicircular, deeply impressed, not reëntrant. Pronotum punctate, external and internal striæ entire, gradually approaching at base, and between them confused striæ usually extending past the middle. Margin of thorax ciliate. Three entire dorsal striæ, the fourth basal, with a faintly defined apical appendix, the fifth apical, faintly defined; the sutural apical, sometimes extending as far as the middle; outer subhumeral a short mark in the basal third, faintly impressed or absent, inner subhumeral visible as a short stria apically, or reduced to a few shallow punctures, which are barely discernible. Elytra red with trapezoidal black spot and black posterior margins; inflexed portion of elytra red, shading to brown at extreme edge. Anterior femora brownish, bidentate, middle and hind femora red, tipped with black at each end. Length (from base of thorax to apex of elytral suture) 3.5 mm.

This species is closely related to *arcuatus*, differing from it only in color, which in *arcuatus* is mahogany and black, while in this species is orange-red and black, and in the distribution of the color. *Arcuatus* has the mahogany spot surrounded with black, the inflexed flanks being black. This species has the inflexed flanks orange-red. *Arcuatus* is slightly larger and more robust.

Described from six specimens; two from Wenatchee, Washington, May 8, 1908 (W. M. Mann); one from Wawawai, Washington, April 24, 1909 (W. M. Mann); one from Corvallis, Oregon, April 20, 1910 (sent to me by C. A. Frost); two in the collection of the American Museum of Natural History from Douglas, Wyoming, and Nevada. The type from Wenatchee, is in my collection; the others are in the collections of Mann, Frost and the American Museum.

Hister ednæ sp. nov.

Oval, black, shining, about the size of *Hister sedecimstriatus*. Head with a few indistinct punctures, frontal stria semicircular, entire, not reëntrant. Prothorax bistriate; the outer stria entire, slightly sinuate; the inner also entire, slightly sinuate, closer to the outer at the base than at the apex, and slightly hooked inward at the base; sparsely punctate laterally inside inner stria for one-half the length of stria from base, also with a finely punctate area in front of the scutellum. Elytra

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 100.

with five deeply impressed striæ, the fourth very slightly abbreviated at base; the fifth arching at base and joining the sutural; oblique humeral finely impressed; subhumeral subentire, not quite attaining the base, deeply impressed; the inner subhumeral represented by a series of distant punctures in the apical half. Propygidium bordered by fine, dense punctures, inside of which are very coarse punctures which become more widely separated towards the center and apex, which is nearly smooth. Pygidium much more finely and densely punctate, the punctures becoming more sparse at the apex. Prosternal lobe margined. Mesosternum subtruncate, with an entire marginal stria which is deeply impressed. Anterior tibiæ five-dentate; the four lower teeth large and distinct, the upper tooth reduced to a small denticle; the first tooth not bifid. Length (from base of thorax to apex of elytral suture) 2 mm.

This well-marked species cannot be assigned to any of Horn's groups. In general appearance and elytral striation it closely resembles *sedecimstriatus*, but the single subhumeral, the presence of two entire thoracic striæ, and the slightly emarginate mesosternum prevent its being placed in the *americanus* group; it cannot be placed in the *servus* group to which its mesosternum would lead because of the entire subhumeral, the five entire dorsal striæ and the five-dentate tibiæ, nor can it be placed in the *merdarius* group because of the completeness of the elytral pattern. It should be placed as a connecting link between the *servus* and the *americanus* groups.

Described from two specimens collected at Southern Pines, North Carolina, March 19, 1912. (A. H. Manee.) The type is in my collection.

SOME MYRMECOPHILOUS INSECTS FROM HAYTI

By WILLIAM M. MANN

[Reprinted from Psyche, Vol. XXII, No. 5]

SOME MYRMECOPHILOUS INSECTS FROM HAYTI.[1]

By William M. Mann,
Bussey Institution, Harvard University.

The insects here noted were collected in Hayti during the winter of 1912–13. Few myrmecophilous insects have been recorded from the West Indies, though no doubt many occur there as the ant fauna is varied and abundant and contains many ancient types. Of these *Aphænogaster relicta* Wheeler & Mann is the predominant Myrmicine ant on the island, and this species was found to harbor several interesting inquilines.

In addition to the species recorded in these notes several others of possibly myrmecophilous habits were taken. I hope to list these after further study.

Mr. A. B. Wolcott, of the Field Museum at Chicago, has very kindly drawn the accompanying figures.

The types of the new species have been deposited in the Museum of Comparative Zoölogy at Cambridge.

ORTHOPTERA.

Family Gryllidæ.

Myrmecophila prenolepidis Wasmann.

A single specimen was taken from a colony of *Prenolepis longicornis* Latr. at Manneville near the shores of Lake Assuei. Another

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 101.

was seen in this locality in a nest of the same species of ant, but escaped. This cricket was described by Wasmann from examples sent to him from India by P. J. Assmuth, and from Pará, Brazil, by E. A. Göldi. In both localities the host ant was *Prenolepis longicornis*. Wasmann's Brazilian specimens were lighter in color than those from India and the light transverse abdominal band was indistinct. The Haytian example is more like the Indian form, being dark brown in color with a distinct light yellowish band transversely across the first segment of the abdomen.

This cricket and the beetle, *Coluocera maderæ* Woll., are the characteristic guests of *Prenolepis longicornis*. The host ant is one of the most widely distributed of all the Formicidæ. It has been recorded from practically all tropical and subtropical regions, and occurs occasionally even in the temperate parts of the world, where it has been introduced through commerce. Nests are of common occurrence on shipboard. It is evident from the varied localities from which the two inquilines have been recorded, that they are capable of adapting themselves to the different environments in which the host nests, and that they are extending their range, following the ant in its wanderings.

HEMIPTERA.

Family Cercopidæ.

Two nymphs of an undetermined Cercopid were found with large colonies of *Aphœnogaster relicta* subsp. *epinotalis* Wheeler & Mann at Manneville. The body of this Hemipteron is very much flattened dorsoventrally, so that it has the appearance of a small cockroach, which it resembles also in its manner of running.

Family Membracidæ.

A single immature individual of an undetermined Membracid was found living in a nest of *Macromischa sallei* subsp. *haytiana* Wheeler & Mann at Furcy. Enslin has recently observed (Zeits. f. wiss. Insektenbiol. Vol. VII, pp. 19–21) that the European ant *Formica cinerea* F. often carries into its nests nymphs and adults of *Gargara genistæ* F., a common European Homopteron. Those which he observed soon died, probably because of lack of food in the subterranean nests of the ants. The nest of Macromischa,

which is built of carton about the branches of living shrubs, offers available food supply to any Homopteron that might enter or be carried into it. Still the habit can not be very general, for numerous nests were examined and no more individuals were found.

Fustiger haytiana sp. nov. (Figs. 1 and 2.)

Length, 2.25 mm. Color yellowish brown, the head, antennæ and prothorax considerably darker than the abdomen. Head a little more than twice as long as broad, broadest behind the eyes, from which the sides are nearly straight and slightly converging to occiput; occipital corners angulate, the border deeply concave; sides in front of eyes slightly convex, nearly as widely separated at base of clypeus as at eyes, eyes convex, about one sixth as long as head; antennæ slightly longer than head, third joint clavate, constricted at basal third, about seven times the length of the second, broadly rounded at apex; head and antennæ subopaque, coarsely rugulose-punctate, beset with short yellowish hairs, which are erect on head and at apex of antennæ, and semi-recumbent on remainder of antennæ. Prothorax as long as head, broadest in front of middle, narrowed anteriorly; sides posterior to the broadest part slightly concave; posterior corners angulate, the border slightly concave; disc with a large shallow, median fossa a little posterior to the middle. Elytra shining, finely, sparsely punctate, with scattered, short, erect hairs; together three fourths as long as broad; anterior border concave; sides rounded, gradually diverging to the posterior border; posterior corners rounded. Inner border of each elytron strongly, though narrowly margined, with an entire stria approximate and parallel to the margin. Abdomen shining, finely punctate and with erect hairs; at base a little narrower than the elytra; first segment basally very deeply impressed transversely and having on either side of this depression a large rounded tubercle which bears a thin bunch of short, recumbent hairs; sides rounded, margined, with strong striæ that extend from the middle of tubercles to the apical corners of first segment. Propygidium about three times as broad as long. Legs rather slender; tibiæ apically as thick as the femora; with suberect hairs. Middle femora with a long, curved, blunt process near the base. Ventral surface shining, minutely punctate.

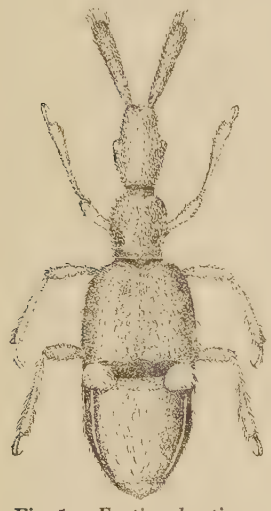


Fig. 1. *Fustiger haytiana* sp. nov.

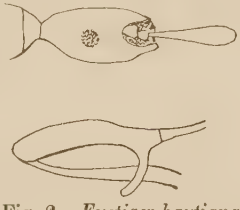


Fig. 2. *Fustiger haytiana* sp. nov. above, head from side; below, middle femur.

Described from a single specimen taken at Diquini in a nest of *Aphœnogaster relicta*. The only other West Indian Fustiger is *F. smithi* Raf. from St. Vincent. *F. haytiana* differs in being larger (*smithi* is only 1.65 mm. in length) and in not having the elytra rugosely punctate at base.

Family Lathridiidæ.

Coluocera maderae Woll.

Taken in numbers at Manneville, in company with *Prenolepis longicornis*.

This beetle was first described from Madeira, where it was found in the nest of an ant. The name of the host was not given, but Wasmann reasonably supposes that it was *Prenolepis longicornis*. This author has given an interesting account of the beetle (Zeitschr. f. wiss. Insektenbiol. 1905, pp. 384–390), in which he records it from India, Pará, Brazil, and the island of Trinidad as well as from Madeira. In each locality it occurs with *Prenolepis longicornis*, but in India it has been found also with *P. indica* Forel and also with species of the genus *Pheidole*, however, usually with the first named ant. Assmuth notes (Zeitschr. f. wiss. Insektenbiol. 1907, p. 330) that at Bombay, India, it is very abundant, while rare at Khandalo. In Hayti about Lake Assuei it was abundant, but sporadic. Dozens of specimens occurred in some nests while in the immediate vicinity others would not contain a single individual, and although the host ant is common throughout the island at the lower altitudes, I did not find the beetles in any other locality.

HYMENOPTERA.

Family Bethylidæ.

Pseudisobrachium terresi sp. nov.

Female (Fig. 3): Length, 6 mm. Color black, except the mandibles, antennæ and legs exclusive of the outer side of the front coxæ, which are rufous, and the apical margins of abdominal segments, which are indistinctly rufous. Head one and one fourth times as long as broad, broadest behind base of mandibles; sides subparallel, very slightly convex; occipital margin straight; at corners broadly rounding into the sides; above closely foveolately punctured, except for a narrow, longitudinal, median space extending the entire length, which is smooth. Clypeus very strongly

carinate. Mandibles thick, tridentate. Antennæ short, extending about half their length past the occipital margin, 13-jointed; the scape punctate, as long as the first five joints of the flagellum together; pedical globular; first and second joints of flagellum equal, slightly longer than broad; joints 3 to 10 transverse, subequal; apical joint nearly twice the length of penultimate. Ocelli absent; eyes minute, situated on sides of head at about one sixth the distance from clypeus to occiput. Prothorax one and three fourths times as long as broad, sides nearly parallel, rounded anteriorly, coarsely but sparsely punctate except for a smooth longitudinal median surface; the collar densely, minutely striolate transversely. Mesothorax subcordate, without a scutellum, separated from prothorax by a deep impression; with distinct parapsidal furrows; mesonotal furrows strongly impressed, diverging outwardly at anterior border, extending entire length; surface above smooth at middle and in a narrow space outward from the furrows and parallel to them, elsewhere with scattered coarse punctures. Metanotum twice as long as broad, broadest behind middle, smooth at middle, coarsely punctate at sides, posterior portion delicately striolate transversely. Abdomen cylindrical, about three times as long as broad, with fine scattered punctures. Legs stout, finely punctate, middle tibiæ and tarsi spinose.

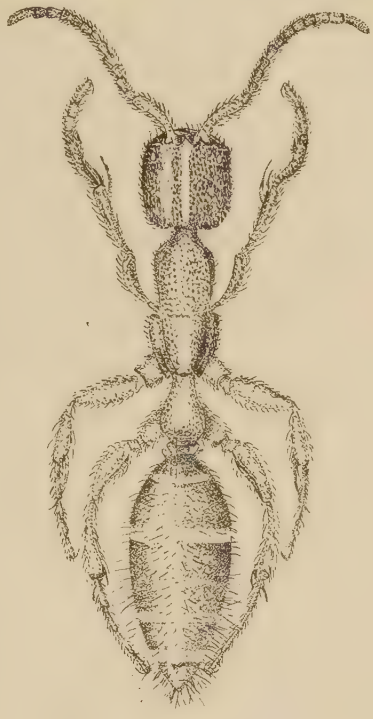


Fig. 3. *Pseudesobrachium terresi* sp. nov.

Body shining, with scattered yellow hairs, which are most abundant on abdomen, legs, head and antennæ.

Described from a single specimen taken in a nest of *Aphœnogaster relicta* at Diquini. The species is named after Dr. John B. Terres, United States Consul General to Hayti, in recognition of his interest in the fauna of the island. The only other species of *Pseudisobrachium* known to occur in the West Indies are *P. collinum* and *P. albipes* which were described by Ashmead from males taken in St. Vincent. Besides *terresi* the habits of only five species of this genus have been recorded and these all live

in ant nests, where it is to be supposed they are parasitic on the immature stages of the hosts.

DIPTERA.

Family Syrphidæ.

Several pupæ of a Microdon-like insect were found at Diquini beneath bark with colonies of *Pheidole flavens* Roger var. *haytiana*. These pupæ are small (4 mm. in length) and reticulately tuberculate. Between these tubercles the surface is smooth. The tegument is very thin. I was not able to rear any adults.

With the compliments of the Author.

PRODISCOTHYREA, A NEW GENUS OF PONERINE ANTS FROM QUEENSLAND.[1]

By WILLIAM MORTON WHEELER.

(Communicated by Arthur M. Lea.)

[*From "Transactions of the Royal Society of South Australia," vol. xl., 1916.*]

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tarsi and simple claws; middle tibiae without spurs, hind tibiae with a single large feebly-pectinated spur. Body opaque, sculptured; hairs absent; pubescence short, dense, and silky.

Female (deälated). Very similar to the worker and but slightly larger. Ocelli present, but small; eyes somewhat larger than in the worker. Thorax with distinct pronotal, mesonotal, scutellar, metanotal, and tegular sclerites, and with stumps of the lost wings.

PRODISCOTHYREA VELUTINA, sp. nov.

Worker. Length, about 2 mm.

Head subrectangular, a little longer than broad. decidely narrower in front than behind, very convex above, with straight posterior and rather convex lateral borders and rounded posterior corners. Gular surface rather convex, with a prominent, ridge-shaped tubercle on each side. Clypeus transversely and regularly convex, its anterior border straight and distinctly crenulate, especially in the middle. Frontal carinae extending back about two-thirds the length of the head, dilated and horizontally flattened in the middle, the space between them scarcely concave, rounded anteroposteriorly and continuous with the regular convex surface of the head. Antennal scapes nearly two-thirds as long as the head; scapes incrassated, especially at the apex, where they are nearly one-fourth as broad as their length; first funicular joint rather broad, subglobular, distinctly broader than long; joints 2-5 subequal, very transverse; 6-8 larger and proportionately longer, terminal joint very large, glandiform, as long as the remainder of the funiculus, about two and one-half times as long as broad. Thorax narrower than the head, seen from above trapezoidal, about one and two-fifths as long as broad, and one and one-half times as broad through the humeri as through the epinotum, sides slightly concave; humeri bluntly angular; in profile the thoracic dorsum is very unevenly convex to the declivity of the epinotum, which is abrupt, concave, and marginate on the sides. Each margination merges into a scarcely distinguishable tubercle above, and the base and declivity are separated by a transverse ridge. Petiole from above nearly twice as broad as long, broader behind than in front, with straight anterior and lateral and feebly convex posterior borders; in profile the segment is less than twice as long as high, convex and anteriorly sloping above and on the sides, its ventral surface compressed and translucent anteriorly, but without a spine

or tooth. Postpetiole convex above, one and one-quarter times as long as broad, much broader behind than in front, where it is as broad as the posterior border of the petiole, the ventral surface anteriorly with a blunt, transverse tubercle. First gastric segment separated by a slight constriction from the postpetiole, as broad as long, very convex dorsally, and rapidly narrowed behind to the small remaining segments. Legs moderately long, tarsi slender. Opaque; gaster and legs somewhat shining. Mandibles densely and finely punctate-rugulose. Head, thorax, petiole, and postpetiole uniformly and densely foveolate (thimble-pitted), gaster and legs very finely and densely punctate and shagreened; antennal scapes with smaller and more scattered foveolae than the head. Hairs lacking; whole body covered with short, fine, dense, silky, yellowish-white pubescence, so that the surface appears like velvet under a low magnification. Rich ferruginous-red; gaster and legs, including the coxae, slightly paler and more yellowish; edges of frontal carinae, posterior border and a median dorsal line on the postpetiole, and a similar line on the first gastric segment deep brownish-red.

Female (deälated). Length, about 2·4 mm.

Differing from the worker in the larger eyes, the presence of ocelli, and the structure of the thorax. Pronotum twice as broad as long and very short in the middle, owing to the extension forward of the mesonotum, which is as long as broad, evenly convex above, with distinct parapsidal furrows. Tubercles of the epinotum distinctly larger and more acute than in the worker.

Described from 39 specimens, one female and 38 workers, constituting an entire colony taken by myself October 24, 1914, in a small clearing in the tropical "scrub" (rain forest) at Kuranda, Northern Queensland. The nest was of peculiar structure, being a small, regularly-elliptical cavity, 2 cm. long by 1·5 cm. in width, in the soil under the centre of a large flat stone. This cavity was completely lined with the dense, white mycelium of a fungus, on which the ants were quietly resting. When disturbed their movements were very slow, and many of them curled up and "feigned death." I could find no larvae in the cavity, but there were several small, pinkish, spherical bodies, which I took to be parts of the fungus. The nature of the delicate layer of nutrient substratum on which the hyphae were growing could not be ascertained. The colour, sculpture, and velvety texture of the ants and their timid behaviour are strikingly like those of certain species of the neotropical fungus-growing tribe

Attiini (notably species of *Sericomyrmex* and *Apterostigma*).[2] These peculiarities, and the fact that the colony was completely shut off from the outside world by a layer of mycelium, strongly suggest that *Prodiscothyrea velutina* is a fungus-growing and fungus-eating ant. Should further research prove this supposition to be correct, the insect would be of considerable interest as the first case of a fungus-gardener among the ants of the Old World, and the first to exhibit the habit among the members of the subfamily Ponerinae. As the Ponerinae are by common consent regarded as a very ancient and primitive group, we should have to infer that the habit was probably of great antiquity, and had been acquired independently at least twice during the phylogeny of the Formicidae. The possibility of a third independent development of the habit is, indeed, suggested by the extraordinary Myrmicine ant *Proatta butteli*, recently described by Forel from Sumatra, because it is structurally very similar to certain species of the Attiine genus *Mycocepurus*, but von Buttal-Reepen did not find it associated with fungi, but in the carton nest of a termite (*Hamitermes dentatus*, Harv.), which does not cultivate fungi like many of the Old World termites.

Prodiscothyrea evidently belongs to Emery's tribe Proceratiini, and is very closely related to *Discothyrea*. In this genus, however, the antennae are 9-jointed, the clypeus forms a semicircular disc instead of a very short, transverse plate, the frontal carinae are very much smaller and shorter, there are no large impressions on each side of the head for the accommodation of the antennal scapes, the eyes are smaller and at the middle of the sides of the head, and in the female the eyes and ocelli, judging from the descriptions, are much larger. Like *Discothyrea* and *Spaniopone*, *Prodiscothyrea* is related to *Bradoponera* of the Baltic amber, which is of the lower Oligocene age. The Australian genus is evidently an ancient Mesozoic genus, like Paranomopone, which I recently described, from the same locality in Northern Queensland (Psyche, xxii., 1915, pp. 117-120, pl. 1). The great antiquity of the tribe Proceratiini is attested by its wide geographical range and the sporadic occurrence of species of *Proceratium*, *Discothyrea*, and *Sysphincta* in widely separated regions of both hemispheres.

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[2] The peculiar structure of the toothless mandibles, with the dense, regular row of short setae along their apical borders, is also suggestive of habits which require the manipulation of such delicate bodies as fungus hyphae, though I know of no similar structures in our American fungus-growing ants.

EXPLANATION OF THE PLATE.

Fig. 1. Worker of *Prodiscothyrea velutina*, sp. nov., from the side.
,, 2. Head of same from above.
,, 3. Head from below.
,, 4. Head from behind.
,, 5. Mandible from below.
,, 6. Extensor surface of antenna.
,, 7. Dorsal view of thorax, petiole, and postpetiole.
,, 8. Middle leg.
,, 9. Hind leg.

AMENDING NOTE.

Professor Wheeler writes that it is necessary to make some amendments to his paper dealing with the ants, taken by Captain White, in last year's Transactions; as "I find that the name *Polyrhachis longipes* [3] is preoccupied, and I would substitute for it *Polyrhachis macropus*. The name *Camponotus aurofasciatus* [4] was given by mistake to the minor worker of *Camponotus (Myrmotrema) inflatus*, Lubbock, as I find from examination of some of the material you sent me for study. The minor worker of this ant had not been described, and is so different from the major worker of *inflatus* that I did not recognize it as belonging to that species."

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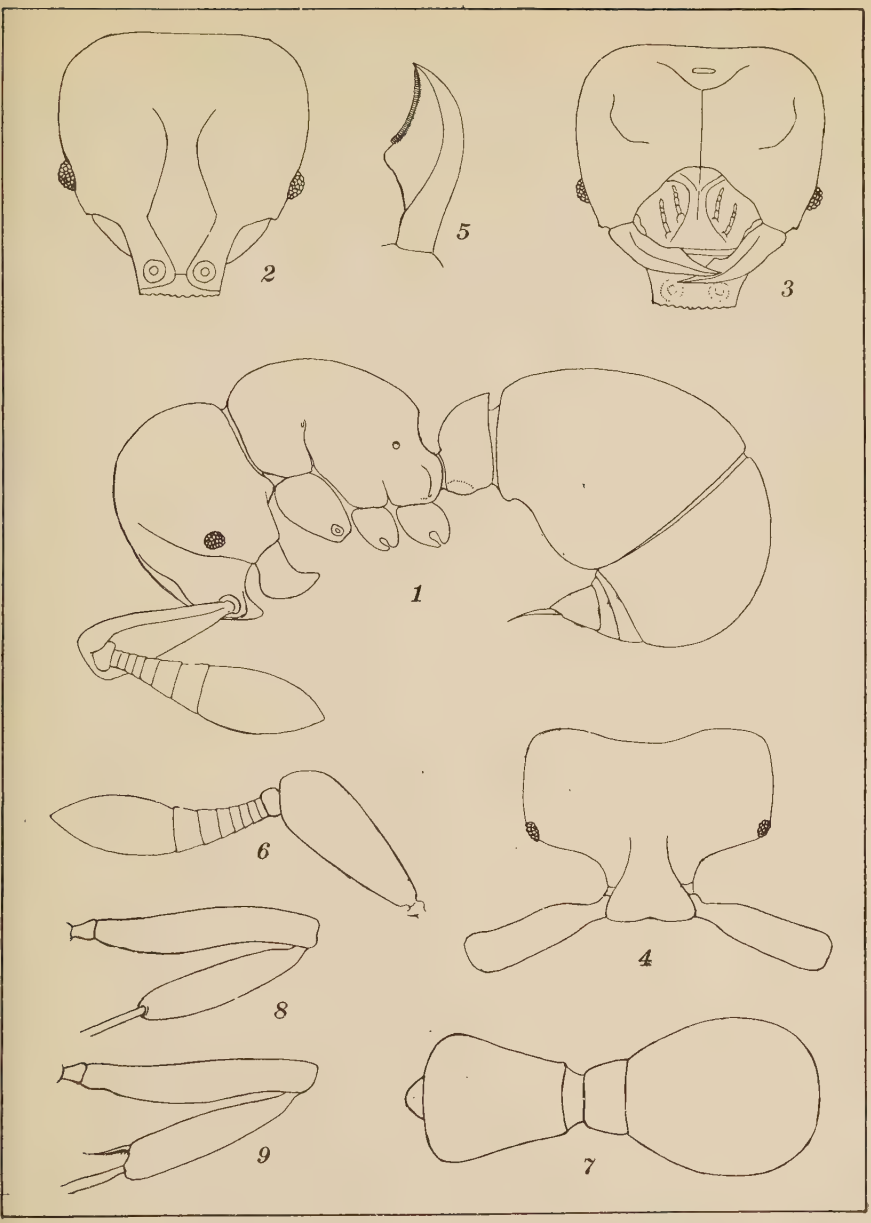
[3] *Ante*, 1915, p. 821.
[4] *L.c.*, p. 817.



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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LIX. No. 7.

TWO NEW GENERA OF MYRMICINE ANTS FROM BRAZIL.

By William Morton Wheeler.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
November, 1915.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUTENANT COMMANDER L. M. GARRETT, U. S. N., COMMANDING, PUBLISHED OR IN PREPARATION:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
H. B. BIGELOW. XXIII.[23] The Siphonophores.
H. B. BIGELOW. XXVI.[26] The Ctenophores.
R. P. BIGELOW. The Stomatopods.
O. CARLGREN. The Actinaria.
R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
H. L. CLARK. The Starfishes.
H. L. CLARK. The Ophiurans.
S. F. CLARKE. VIII.[8] The Hydroids.
W. R. COE. The Nemerteans.
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[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
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[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
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[8] Mem. M. C. Z., Vol. XXXV., No. 1, February, 1907, 20 pp., 15 pls.
[9] Bull. M. C. Z., Vol. L., No. 6, February, 1907, 48 pp., 18 pls.
[10] Mem. M. C. Z., Vol. XXXV, No. 2, August, 1907, 56 pp., 9 pls.
[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls.
[15] Bull. M. C. Z., Vol. LII., No. 5, October, 1908, 11 pp., 2 pls.
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
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[18] Bull. M. C. Z., Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909, 10 pp., 3 pls.
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
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[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls.
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV, No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem. M. C. Z., Vol. XXXV., No. 4, July, 1912, 124 pp., 12 pls.
[28] Bull. M. C. Z., Vol. LVIII., No. 8, August, 1914, 14 pp.
[29] Mem. M. C. Z., Vol. XLII., June, 1915, 397 pp., 109 pls.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LIX. No. 7.

TWO NEW GENERA OF MYRMICINE ANTS FROM BRAZIL.

By William Morton Wheeler.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

November, 1915.

No. 7.— *Two New Genera of Myrmicine Ants from Brazil.*

CONTRIBUTIONS FROM THE ENTOMOLOGICAL LABORATORY OF THE BUSSEY INSTITUTION, HARVARD UNIVERSITY. NO. 103.

By William Morton Wheeler.

Mr. C. William Beebe, of the New York Zoölogical Park, recently sent me for identification nineteen vials of ants which he collected May 15, 1915, in a suburb of Pará, at the mouth of the Amazon. The specimens were all taken from four square feet of jungle mold at the foot of a single tree, whose bird fauna (76 species!) Mr. Beebe studied for a week. In addition to the ants he took from the same little patch of mold a number of beetles, termites, springtails, bugs, pseudoscorpions, ticks, mollusks, and worms. The collection of ants comprises seventeen species, two of which are of singular structure and evidently represent new genera. The fifteen other species are recorded in the following list:—

Pachycondyla harpax Fabr. One worker.

Euponera (*Trachymesopus*) *stigma* Fabr. Two workers.

Ponera opaciceps Mayr. Six workers.

Anochetus mayri Emery. One deälated female.

Solenopsis subtilis Emery. Fifteen workers, one male, and one deälated female.

Crematogaster victima F. Smith, var. One deälated female.

Pheidole flavens Roger subsp. *exigua* Emery. One soldier, three workers, three males, and one deälated female.

Pheidole subarmata Mayr. Two workers and one deälated female.

Trachymyrmex sp. One deälated female, without head.

Cyphomyrmex rimosus Spin. One deälated female.

Rhopalothrix (*Octostruma*) *balzani* Emery. Twelve workers and one deälated female.

Strumigenys subedentata Mayr. One deälated female.

Prenolepis steinheili Forel. Four workers and three males.

Rhizomyrma goeldii Forel. Nine workers.

Camponotus (*Myrmothrix*) *abdominalis* Fabr. var. One deälated female.

The solitary deälated females of the species of Anochetus, Crematogaster, Trachymyrmex, Cyphomyrmex, and Camponotus were evi-

dently establishing colonies. At least eight of the species, viz. those belonging to the genera Euponera, Ponera, Solenopsis, Rhopalothrix, Strumigenys, Rhizomyrma and the two new genera Blepharidatta and Glamyromyrmex are hypogaeic (subterranean) ants, with small-eyed workers. With the exception of *Pachycondyla harpax* and *Camponotus abdominalis* all of the species are small or very small. I subjoin descriptions of the two peculiar species representing new genera.

Blepharidatta, gen. nov.

Worker. Small, monomorphic. Mandibles triangular, their apical margins with a few subequal teeth. Clypeus vertical, bicarinate. Frontal area large, frontal groove absent. Eyes moderately large and very convex. Ocelli lacking. Antennae 11-jointed, funiculus with a well-defined 2-jointed clava. Head rather large, with a deep scrobe on each side, extending its full length and bordered above by the frontal carinae which are large, expanded and horizontal, lobulate in front and extending to the posterior corners of the head. The inferior or lateral border of each scrobe is formed by a ridge as long as the frontal carina and running just above the eye. Thorax moderately long and slender, without promesonotal and mesoëpinotal sutures; humeri and inferior angles of pronotum dentiform; epinotum armed with a pair of long spines; metasternal angles large, compressed and sharply angular above. Petiole long and slender, pedunculate, with a low, rounded node. Postpetiole small, subglobular. Gaster small, spherical, first segment very large, without ridges, grooves or tubercles; remaining segments very small. Sting vestigial. Legs rather slender; middle and hind tibiae without spurs; claws simple.

Head, thorax, pedicel, and appendages opaque, sculptured; gaster smooth. Upper surface of body beset with long, paired, very sparse, stiff, and blunt hairs.

Blepharidatta brasiliensis, sp. nov. (Fig. 1).

Worker. Length nearly 2 mm.

Head nearly $\frac{1}{3}$ longer than broad, narrower in front than behind, with strongly and broadly excised and marginate posterior border and nearly straight lateral borders, its dorsal and gular surfaces feebly

convex, its posterior corners produced as prominent angular tubercles. Scrobes of nearly uniform transverse diameter throughout their length and sufficiently deep to accommodate the antennae. Frontal carinae expanded and lobular anteriorly, with translucent and slightly reflected borders throughout their length. Mandibles rather large, with moderately convex external borders, the apical borders rather oblique, with four subequal teeth. Clypeus with evenly rounded, entire anterior border, flattened in the middle between the two prominent longitudinal carinae and transversely impressed at the anterior border. Frontal area semicircular. Antennae slender, scapes reaching nearly to the posterior corners of the head, their apical halves distinctly thickened; first funicular joint large, fully twice as long as broad; joints 2–7 narrower, a little broader than long, joint 8 as long as broad; joint 9, the basal joint of the clava, longer than broad and twice as broad as the preceding joints; terminal joint large, pointed, nearly three times as long as broad. Thorax narrower than the head, more than twice as long as broad, broadest through the humeri, in profile more than twice as long as high, feebly and evenly convex above. Pronotum with acute, dentate anterior corners, from which there run a pair of distinct longitudinal ridges, gradually converging posteriorly to the epinotal spines. Each of these ridges bears two minute teeth. Epinotum sloping, concave in the middle, marginate on the sides below the spines, which are long, straight, acute, close together at their insertions and directed backward, outward and upward. Metasternal angles thin, translucent, broad and sharply angular above. Petiole fully three times as long as broad or high, with a short distinct peduncle in front and constricted behind the node, which is evenly and feebly convex above; seen from above the segment is broadest at its posterior margin. Postpetiole a little broader than the petiole but scarcely higher, from above rectangular, a little broader than long, in profile feebly convex above. Gaster subcircular from above, with straight basal margin.

Gaster smooth and shining; remainder of the body, including the appendages opaque, very finely and densely punctate-rugulose. Head above between the frontal carinae with six coarse, longitudinal rugae connected by sparse, indistinct transverse rugules or reticulations. Pronotum above with four feeble longitudinal rugae. Pleurae very indistinctly and irregularly rugose. Petiole and antennal scapes indistinctly longitudinally rugulose. Postpetiole and legs very finely and densely punctate. Gaster very finely and indistinctly shagreened, at the base above densely punctate and opaque.

Hairs yellowish; those on the upper surface of the body very long, slightly curved, of uniform thickness and blunt, arranged very regularly in pairs. On the head nearly all of them arise from the edges of the frontal carinae where the insertion of each hair is a minute tubercle; on the thorax the hairs are inserted along the ridges connecting the humeral angles with the epinotal spines. The petiole bears three, the postpetiole two pairs of these peculiar pairs. On the gaster there are four regular equidistant rows, with about six hairs in each

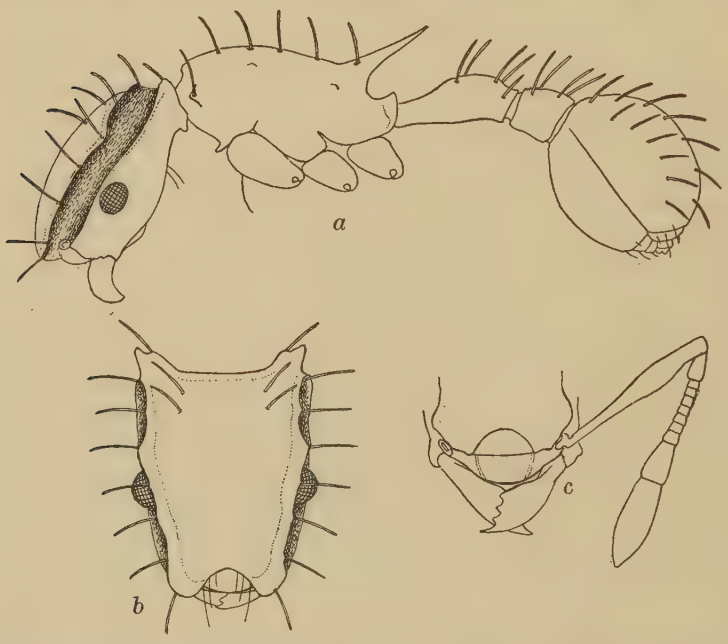

FIG. 1.— *Blepharidatta brasiliensis*, sp. nov. *a*, worker, lateral view; *b*, head of same from above; *c*, mandibles, clypeus and antenna of same from the front.

row. Each fore coxa bears a single long hair and there is a pair of hairs on the gula. Legs, antennae, and terminal gastric segments with numerous, short, appressed pointed hairs and the dorsal surface of the gaster also with a few scattered reclinate hairs.

Color ferruginous; antennae, legs, tip and sides of gaster somewhat paler and more yellowish.

Described from ten specimens; Cotype M. C. Z. 9040.

This extraordinary ant is evidently to be placed in the tribe Attiini,

but it differs so much from the other known genera in the structure of the head and especially in the 2-jointed club of the antennae, the 4-toothed mandibles and the regularly arranged, setiform hairs on the dorsal surface, that it seems necessary to establish a distinct genus for its accommodation. Apart from the head, the structure of the body is very simple and primitive for an Attiine ant, even simpler and more primitive than in the genus Proatta, recently established by Forel for a unique Sumatran species. It would be interesting to know whether *Blepharidatta brasiliensis* cultivates fungi like all the other known American Attiini.

Glamyromyrmex, gen. nov.

Worker. Small, monomorphic; closely related to Strumigenys and Epitritus, but differing greatly from these genera in the structure of the head, which is suboblong, with deep scrobes on the sides above the eyes for the accommodation of the antennae. Lateral border of the head forming with the expanded frontal carina and external border of the clypeus a translucent plate overarching the scrobe on each side. Gular region rather narrow so that the eyes, which are small and in front of the middle of the head are approximated and seem to be on its lower surface. Upper surface of head rather flat, separated by a very indistinct suture from the transverse clypeus. Ocelli, frontal groove, and frontal area absent. Mandibles small, with distinct apical borders, armed with a regular row of rather slender acute teeth. Antennae 6-jointed, funiculus with a 2-jointed clava. Thorax, pedicel, and gaster much as in Strumigenys; petiole, postpetiole, and base of gaster bearing spongiform appendages. Epinotum armed with a pair of spines and with acute metasternal angles. Upper surface of head smooth and shining, sculpture of remainder of body much as in Strumigenys. Hairs slender and pointed, not clavate.

Female. Head decidedly shorter and broader than in the worker and narrowed in front, but otherwise of similar structure. Eyes larger, ocelli well-developed. Remainder of body much like that of Strumigenys, and the wings of similar but even more reduced venation, as the base of the cubital vein is largely obsolete, although the anal vein is present. Petiole, postpetiole, and base of gaster with fungiform appendages as in the worker.

Male. Closely resembling the male of Strumigenys. Mandibles very small, with only a single, apical tooth. Head of the usual struc-

ture, without dilated lateral margins or scrobes. Eyes very large and prominent, ocelli only moderately large and rather far apart. Antennae 13-jointed, with very short scapes. Thorax robust, broader than the head, mesonotum with deep Mayrian furrows, scutellum very convex. Petiole and gaster without fungiform appendages, those on the postpetiole minute and vestigial. Wings as in the female.

Glamyromyrmex beebei, sp. nov. (Fig. 2).

Worker. (Fig. 2*a* and *b*). Length 1.5–2 mm.

Head $1\frac{1}{2}$ times as long as broad, slightly broader behind than in front, with deeply excised posterior and more feebly excised lateral borders and broadly rounded anterior and posterior corners; behind feebly convex, flattened in the middle and with sloping clypeus. Mandibles convex, with about 8 slender and crowded teeth, which are longest at the apex. Clypeus much broader than long, flattened, with arcuately and deeply excised anterior and convex posterior border. Antennal scapes tenuous at the base, somewhat thickened and fusiform in the middle. First funicular joint fully twice as long as broad and much broader than the two succeeding joints; second joint longer than broad, third as broad as long; fourth longer than broad and less than $\frac{1}{3}$ as long as the rather tapering terminal joint. Thorax much narrower than the head, broadest through the pronotum, which is as broad as long and evenly convex above, with minute but distinct humeral angles. Pleurae rather flat. Mesonotum sloping to a feeble constriction in front of the epinotum, the latter a little longer than broad, its base marginate on the sides and passing into the subequal declivity through a blunt angle. Spines laterally compressed, straight and acute, as far apart at their bases as long, directed backward and upward. Petiole fully twice as long as broad, pedunculate in front, with a low rounded node behind and with three spongiform appendages, one forming a narrow longitudinal band on the median ventral surface, the others a triangular mass on each side of the node. Postpetiole transversely elliptical, distinctly broader than the petiole, with a large spongiform mass enveloping its sides and ventral surface. Gaster as large as the head, elliptical, with straight basal border and a small fungiform mass on the anteroventral surface. Legs rather slender.

Smooth and shining; mandibles and head covered with minute, sparse, piligerous punctures, the lateral borders of the head above

longitudinally striate. Gula, pleurae, meso- and epinotum, and petiole opaque, densely and coarsely punctate-rugulose; gaster with a series of strong longitudinal rugae on the dorsal surface at the anterior margin.

Hairs and spongiform appendages sordid yellowish. Head with delicate hairs, which are short, sparse, and appressed on the dorsal

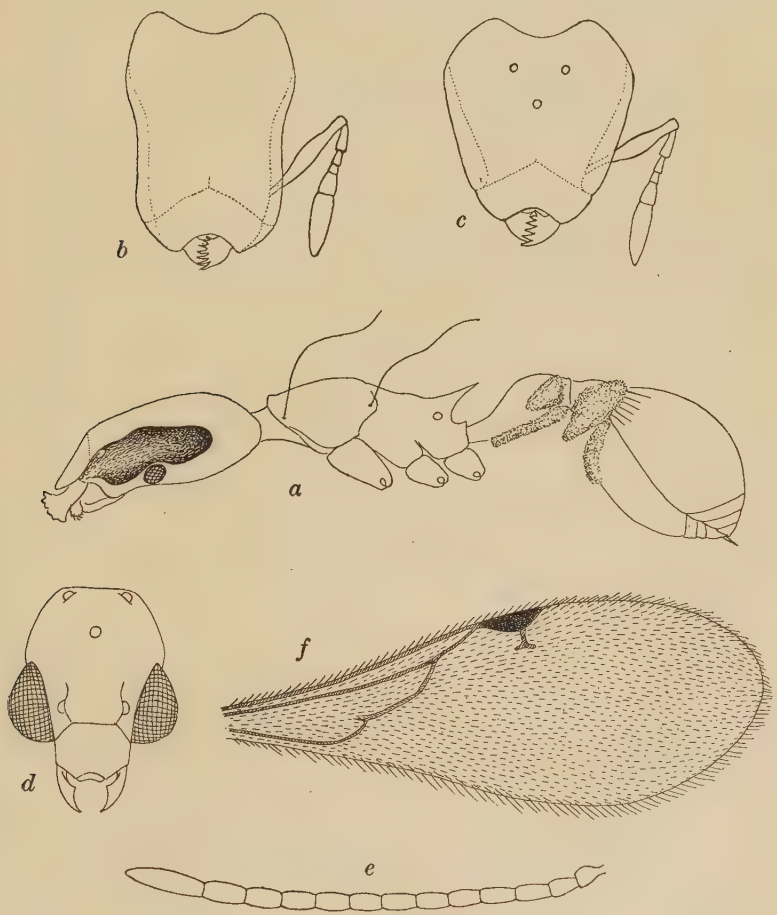

FIG. 2.— *Glamyromyrmex beebei*, sp. nov. *a*, worker, lateral view; *b*, head of same from above; *c*, head of female from above; *d*, head of male from above; *e*, antenna of male; *f*, wing of same.

surface but longer, denser and more oblique on the gula. Thorax with two pairs of very long, slender, flagelliform hairs, one on the humeral angles and one on the posterior corners of the pronotum. Petiole, postpetiole, and gaster with a few long, slender, erect hairs. Antennae and legs with short, subappressed hairs.

Castaneous; upper surface of head and gaster blackish; mandibles, translucent lateral borders of head and clypeus, antennae and legs paler and more reddish or even slightly yellowish.

Female. (Fig. 2*c*). Length 2.6 mm.

Head only slightly longer than broad, decidedly broader behind than in front, with straight sides, deeply concave posterior border and obliquely truncated posterior corners; in other respects, except for the larger eyes and the presence of ocelli, like the head of the worker. Thorax through the wing-insertions nearly as broad as the head, somewhat longer than high, narrowed in the pronotal region, with bluntly angular humeri. Mesonotum flattened above; scutellum convex, with acute, projecting posterior border. Epinotum abrupt and concave in profile, its spines and metasternal angles larger than in the worker, more translucent and compressed. Petiole, postpetiole, and gaster as in the worker.

Sculpture, pilosity, and color as in the worker, but the upper surface of the mesonotum and scutellum is opaque and coarsely longitudinally rugose, with reticulate-rugulose interrugal spaces, the mesopleurae are smooth and shining and the postpetiole is subopaque and finely punctate above. The flagelliform hairs on the humeral angles are shorter and there are numerous erect, slender hairs on the mesonotum. Wings with uniformly brownish membranes, dark brown stigma and resin-colored veins.

Male. (Fig. 2*d*, *e*, and *f*). Length 2 mm.

Head longer than broad, with very short cheeks, feebly rounded postocular borders and rather straight, marginate occipital border. Mandibles very small, triangular, with feebly convex external borders and acute tips. Clypeus a little broader than long, subhexagonal, with the anterior border arcuately excised in the middle. Frontal carinae subparallel, reaching to the middle of the head, rather far apart. Antennae long, their scapes scarcely twice as long as broad and scarcely longer than the first funicular joint; all the funicular joints subcylindrical, longer than broad, the terminal joint longest. Thorax shaped much as in the female but broader than the head. Epinotal spines and metasternal angles shorter and blunter, not compressed and translucent. Petiole with a slightly more angular node in profile, postpetiole more transverse and less elliptical.

Opaque; with only the gaster, mesopleurae, and legs smooth and shining. Head densely and uniformly punctate; thorax, petiole and postpetiole coarsely punctate-rugulose; sides of mesonotum above irregularly and longitudinally rugose. Gaster with short longitudinal rugae at the base.

Hairs pale yellowish, very sparse, slender and rather short and inconspicuous on the body. Flagelliform hairs on the thorax feebly developed. Hairs on the legs delicate, appressed.

Black; thorax and pedicel dark brown; mandibles, antennal scapes, first funicular joint and legs piceous, tibiae and femora darker in the middle. Wing membranes, stigma, and veins distinctly paler than in the female.

Described from three workers, three females and two males belonging to the same colony: Cotype M. C. Z. 9039.

This singular ant belongs to the tribe Dacetoniini and is evidently closely related to the species of Strumigenys, Epitritus, and Pentastruma but differs greatly from these and all the other known members of the tribe in the structure of the head, which recalls that of the Cryptoceriini, though the eyes in this tribe are behind and not beneath the deep antennal scrobes.

The following Publications of the Museum of Comparative Zoölogy are in preparation:—

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
E. L. MARK. On Arachnactis.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
K. BRANDT. The Thalassicolae.
O. CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
H. L. CLARK. The Ophiurans.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds, and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to LIV. and Vol. LVIII.; of the MEMOIRS, Vols. I. to XXIV., and also Vols. XXVI. to XXIX., XXXI. to XXXIV., XXXVI. to XXXVIII., XL. to XLII., and XLIV.

Vols. LV. to LVII., and LIX. of the BULLETIN, and Vols. XXV., XXX., XXXV., XXXIX., XLIII., XLV. to XLIX. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Officers of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation:—

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey, Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

These publications are issued in numbers at irregular intervals. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LX. No. 2.

THE AUSTRALIAN ANTS OF THE GENUS ONYCHOMYRMEX.

By William Morton Wheeler.

With Two Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
January, 1916.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUTENANT COMMANDER L. M. GARRETT, U. S. N., COMMANDING, PUBLISHED OR IN PREPARATION:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
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[27] Mem. M. C. Z., Vol. XXXV., No. 4, July, 1912, 124 pp., 12 pls.
[28] Bull. M. C. Z., Vol. LVIII., No. 8, August, 1914, 14 pp.
[29] Mem. M. C. Z., Vol. XLII., June, 1915, 397 pp., 109 pls.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LX. No. 2.

THE AUSTRALIAN ANTS OF THE GENUS ONYCHOMYRMEX.

By William Morton Wheeler.

With Two Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
January, 1916.

No. 2.— *The Australian Ants of the Genus Onychomyrmex.*

CONTRIBUTIONS FROM THE ENTOMOLOGICAL LABORATORY OF THE BUSSEY INSTITUTION, HARVARD UNIVERSITY. NO. 104.

By William Morton Wheeler.

Twenty years ago Emery described a singular ponerine ant taken by Podenzana on Mt. Bellenden-Ker, in Queensland, as the type of a new genus under the name of *Onychomyrmex hedleyi*, in honor of Mr. C. Hedley, a distinguished Australian naturalist. The worker, which was the only phase seen by Emery, exhibited an unusual combination of characters, especially in the shape of the mandibles, clypeus, petiole, and middle and hind tarsi, the terminal joints, pulvilli, and claws of which were conspicuously enlarged. He regarded the affinities of the genus as obscure. "Its mandibles and petiole," he says, "recall the species of Amblyopone and related genera, but the frontal carinae, approximated and dilated in front, resemble those of Ponera and Leptogenys. The tibiae without spurs are not found in any other Ponerinae. The tarsi, with their enormous claws and pulvilli, have no analogue, to my knowledge, except in the Dorylinae (*Aenictus, Anomma*), but the insertions of the antennae and the structure of the thorax lead me to think that these resemblances do not indicate a true relationship." Ashmead (Can. ent., 1905, **37**, p. 382) regarded the genus Onychomyrmex as constituting a distinct tribe of Ponerinae (Onychomyrmicini). In his recent revision of the subfamily in the "Genera Insectorum" (1911), Emery adopts Ashmead's name as that of a sixth and last subtribe in the tribe Ponerini.

While collecting in the rich tropical "scrub" in the neighborhood of Kuranda, Queensland during the autumn of 1914, I succeeded in finding not only *O. hedleyi*, which had not been recorded for nearly twenty years, but also two additional species of the genus. On returning to Boston I learned that Dr. E. Mjöberg had anticipated me in finding *O. hedleyi* and one of the other species, while he was collecting for the Swedish scientific expedition to Australia during 1910–1913 and that Forel had just described the latter as *O. mjöbergi*. The third species is described in the following pages as *O. doddi*, in

honor of Mr. F. P. Dodd, the well-known observer and collector of Queensland insects. I was so fortunate as to discover the females of *mjöbergi* and *doddi* and the larva of the former species. The female Onychomyrmex is of such an unusual type that it seems advisable to revise the genus in such a way that some of my Australian friends may be able to recognize all the known species at a glance and to make additions to our knowledge concerning their habits.

Unfortunately the male Onychomyrmex is still unknown and will have to be found before the precise status of the genus in the subfamily Ponerinae can be ascertained. Forel does, indeed, describe a male ponerine taken by Mjöberg as that of *O. hedleyi*, but he says that he does this "with a very great interrogation point." He has, in fact, no evidence that the specimen is an Onychomyrmex, except the very inconclusive fact that it was taken in the same locality (Malanda, Queensland) as the worker of *hedleyi*. I deem it advisable, therefore, to assume that the male is unknown till it is actually taken in nests with the workers. Such observations as I was able to make on the habits of the three species of Onychomyrmex are recorded below in connection with the taxonomic descriptions. So far as at present known all the species of the genus are confined to Queensland, and all live in red rotten logs in the tropical rain-forest ("scrub").[1]

Onychomyrmex Emery.

Emery, Ann. Soc. ent. Belg., 1895, **39**, p. 349; Genera Insectorum, 1911, fasc. 118, p. 96; Forel, Arkiv. f. zoöl., 1915, **9**, p. 2.

Worker. Small, slender, monomorphic. Mandibles rather long, narrow at the base, broadest in the middle, with long, curved, acute tips, their inner borders armed with a number of unequal teeth, some of which, near the middle of the series, are directed backward. Both the maxillary and labial palpi very short, 2-jointed. Clypeus very short, abrupt, with rounded, entire anterior border beset with a regular row of minute teeth. Frontal carinae small, prominent, closely approximated, enlarged and dilated anteriorly, separated by a very narrow groove. Frontal groove lacking. Eyes very small, consisting of about 6 or 8 ommatidia, situated behind the middle of the head.

[1] Emery believed that the *Anomma erratica* of Frederick Smith from New Guinea might be an Onychomyrmex, but the description mentions none of the distinctive characters of this genus and was, perhaps, drawn from an Aenictus.

Antennae 12-jointed, funiculus filiform, not clavate or conspicuously enlarged at the tip. Thorax slender, with very distinct promesonotal and mesoëpinotal sutures; mesonotum small, discoidal, with distinct sutures on all sides. Petiole with a short peduncle in front and a large, prominent compressed ventral projection, the node rounded, scarcely narrowed behind where it articulates by means of its whole posterior surface with the postpetiole. Postpetiole large, convex below, separated by a pronounced constriction from the gaster, which is rather short. Sting very long and well-developed. Legs long; middle and hind tibiae without spurs; terminal joints of the middle and hind tarsi conspicuously elongated and incrassated, with very large, strongly curved, simple claws and large pulvilli.

Female. Apterous and ergatomorphic. Head broadened in front and more depressed at the anterior corners than in the worker. Eyes very small; ocelli absent. Mandibles more falcate, not abruptly curved at the tips, with only a few short, blunt teeth. Mesonotum somewhat longer than in the worker. Petiole differing from that of the worker in being much broader, with a very short and narrow peduncle and lacking the ventral projection. Constriction between the postpetiole and gaster much less distinct than in the worker. Gaster much larger, elongate elliptical, sting somewhat smaller. In other respects like the worker.

Larva. Slender, smooth and nontuberculate, with twelve very distinct postcephalic segments, the constrictions between which are everywhere deep and conspicuous, even at the posterior end of the body. Head short, rounded, with well-developed, slender, acute, falcate mandibles, destitute of teeth. Clypeus rather long, projecting. Antennae very small. Maxillary sensillae long and prominent. Head sparsely, remainder of body more densely and uniformly covered with short, straight, stiff hairs or bristles.

Genotype: *Onychomyrmex hedleyi* Emery.

The discovery of the ergatoid female of Onychomyrmex only adds to our perplexity in regard to the precise taxonomic position of the genus. Similar females are known to occur in a few other ponerine genera, notably in Acanthostichus, Paranomopone, which I recently described from Queensland, and Leptogenys (subgenus Lobopelta), but all of these, together with Onychomyrmex, belong to very different sections of the subfamily, and the resemblances between them seem to be due to "convergence" and not to morphological relationship, or common phylogenetic development. The thorax of the female has simply assumed the structure of that of the worker, while the

gaster is greatly expanded to accommodate the voluminous ovaries. On closer examination it is found that in each of the four genera mentioned the female differs from the congeneric worker in certain peculiar characters. This will best be seen by a comparison of the worker and female Lobopelta with the corresponding phases of Onychomyrmex. Many years ago I called attention to the fact that the female *Lobopelta elongata* Buckley of Texas has no winged female, but that each colony contains a single egg-producing individual, which agrees in all respects with the worker, except in the larger size of the abdomen and the somewhat more compressed petiolar scale. While at Kuranda I succeeded in finding two females of another species (*Leptogenys* (*Lobopelta*) *fallax* Mayr subsp. *fortis* Forel), a small-eyed form which lives, like the species of Onychomyrmex, in red rotten logs in the primeval rain-forest. One of these females was the mother of a flourishing colony of perhaps 300 workers, the other was isolated in a small cavity in a large log and was, therefore, about to start a colony. I have figured one of the specimens (Plate 2, fig. 8, 9), with the worker (fig. 6, 7) to show the difference between them (in this case greater than those obtaining between the female and worker of *Lobopelta elongata*) and between the corresponding phases of *Onychomyrmex mjöbergi* and *doddi* (Plate 1, fig. 3–6; Plate 2, fig. 3–5). It will be seen that in the Lobopelta female the petiole is very much more compressed and more curved forward than in the worker, the thorax more convex and furnished with a small scutellar sclerite and that the head is more orbicular and less rectangular and has distinctly larger eyes and a single ocellus. In the female Onychomyrmex the eyes are not larger than in the worker, there are no traces of ocelli, the head is dilated anteriorly, with rather straight, posteriorly converging sides, and with very different mandibles, while the petiole exhibits a peculiar modification as compared with that of Lobopelta, being greatly swollen behind and much contracted in front. The female Acanthostichus differs from the worker, according to Emery, in its rounded head, larger eyes, the presence of three ocellar pits, more widely separated frontal carinae, broader thorax, much larger abdomen, the absence of prickles on the sides of the pygidium, and a different pubescence on the abdomen. The only external differences between the female and worker Paranomopone are the presence of a median ocellus in the former and a larger postpetiole and gaster. These comparisons all point to the conclusion that in each of the four genera ergatomorphic females have been developed independently by simplification, or atrophy from the primitively winged type of female during

the long phylogenetic history of the ponerine subfamily. It is also probable that the very similar "dichthadiiform" females of the ants belonging to the subfamily Dorylinae have had a like independent origin and development.

The larva of Onychomyrmex (Plate 1, fig. 7; Plate 2, fig. 1, 2), in the very distinct segmentation of the body and in the structure of the head, seems to be of a rather primitive type and resembles the larvae of the Dorylinae (Eciton) and lower Ponerinae (Acanthostichus, Cerapachys), but the larvae of ants have not been sufficiently studied to enable us to draw satisfactory conclusions concerning the phylogenetic relationships of the various genera.

A study of the worker Onychomyrmex certainly reveals a number of highly specialized characters. Such are particularly the shape of the mandibles, the vestigial condition of the palpi, the small size of the eyes, and the enlargement of the terminal joint, claws, and pulvilli of the middle and hind tarsi. The degenerate visual organs show that these ants belong to the hypogaeic series and that they pass their lives concealed in the logs which gradually decompose in the moist shade of the dense tropical jungle. The powerful, toothed mandibles, long sting and great hooked claws indicate that their possessors do not feed habitually on small feeble insects like termites, but on much larger creatures such as the larvae of passalids and scarabaeids and possibly on adult myriopods and scorpions. This I found to be the case in a colony of *O. mjöbergi*, for when the log containing it was broken open, many of the workers were detected in the act of biting and stinging to death a huge lamellicorn beetle larva more than two inches in length, which they had just found in a cavity in the wood. It is not improbable that the colonies move from place to place in search of their prey, like the colonies of the subterranean Dorylinae (*Eciton coecum* and Dorylus), which they very closely resemble in behavior, color, sculpture, and pilosity.

The species of Onychomyrmex are far from common even in Queensland, and the few colonies I secured were the reward of many hours of search and of the destruction of many old logs in places where I was frequently attacked by land-leeches and saw quite a number of the deadly black snakes (*Pseudechis porphyriacus*). Perhaps it would be possible for the collector to attract colonies by placing large beetle or cossid larvae in holes in the rotten logs usually found along the paths through the "scrub."

Onychomyrmex hedleyi Emery.

Plate **1**, fig. 1, 2.

Emery, Ann. Soc. ent. Belg., **39**, 1895, p. 350, f. 2. ☿ ; Gen. Insect., 1911, fasc. 118, p. 97, pl. 3, f. 9, 9*b*; Forel, Arkiv. f. zool., 1915, **9**, p. 3, pl. 1, f. 3 ☿ ♂ (?).

Worker. Length 3.5–4 mm.

Head about $1\frac{1}{4}$ times as long as broad, subrectangular, a little broader in front than behind, with straight sides and posterior border and rounded posterior corners. Clypeus with the anterior border slightly flattened, arcuately rounded in the middle, sinuate at the sides, its edge beset with about 20 minute, regular teeth. Eyes with about 6–8 minute ommatidia, situated $\frac{3}{5}$ the length of the head from the anterior margin. Mandibles with long, abruptly incurved apical tooth and seven basal teeth of different sizes, the two in the middle of the series largest and directed backward. Antennae slender, scapes fully $\frac{4}{5}$ as long as the head, first and last funicular joints twice as long as broad, remaining joints about $1\frac{1}{2}$ times as long as broad. Thoracic sutures all strongly impressed; pronotum convex above, especially in front, with convex sides, a little longer than broad; mesonotum nearly twice as broad as long; epinotum longer and narrower than the pronotum, longer than broad, with feebly convex sides and separated in dorsal view from the pronotum by a pronounced impression on each side. In profile the thorax is distinctly impressed at the mesonotum, the base of the epinotum is nearly twice as long as the straight declivity into which it passes through an obtuse angle. Node of petiole in profile with rather straight anterior slope and convex summit, slightly concave at the posterior border; from above the node is as long as broad, rounded in front, with straight posterior border; ventral projection long and blunt, compressed and somewhat translucent. Postpetiole as long as broad, first gastric segment a little longer than the postpetiole. Legs slender.

Very smooth and shining; mandibles, clypeus, and cheeks subopaque, the mandibles finely striated, the clypeus and cheeks finely rugulose-punctate. Body with fine, sparse, piligerous punctures, which are most numerous on the head, especially on its sides.

Hairs delicate, pale yellowish, short, suberect, covering not only the whole body, legs, and antennal scapes but also the funiculi;

somewhat longer and sparser on the thorax, abdomen, and legs than on the head and antennae.

Black; thoracic sutures, sides and terminal segments of abdomen, clypeus, cheeks, and anterior portion of gula reddish castaneous, mandibles, except their teeth, antennae, and legs paler, brownish red, middle portions of femora and tibiae more or less infuscated.

Queensland: Mt. Bellenden-Ker, type locality (Podenzana); Malanda (E. Mjöberg); Kuranda (Wheeler and F. P. Dodd).

I took two small companies of this ant, unaccompanied by larvae or females, Oct. 24 and 28, evidently on foraging expeditions in the heart of rotten logs. One of the companies comprised a dozen, the other about two dozen workers. Later Mr. Dodd sent me eight workers which he had taken in the same locality. The ants moved rather slowly and were easily captured.

Onychomyrmex mjöbergi Forel.

Plate **1**, fig. 3–7; Plate **2**, fig. 1, 2.

Forel, Arkiv. f. Zool., 1915, **9**, p. 5, pl. **1**, f. 7; text fig. 1, ♀.

Worker. Length 3.5–4 mm.

Head subrectangular, not more than $\frac{1}{6}$ longer than broad, scarcely broader in front than behind, with feebly and evenly convex sides, feebly concave posterior border and rounded posterior corners. Clypeus with broadly arcuate anterior border, sinuate on each side, minutely and evenly denticulate. Eyes scarcely smaller than in *hedleyi*, situated about $\frac{2}{3}$ the distance from the anterior to the posterior border of the head. Mandibles similar to those of *hedleyi*. Antennae shorter, scapes only $\frac{2}{3}$ as long as the head, first and last funicular joints nearly twice as long as broad, remaining joints not longer than broad, the more basal joints a little broader than long. Thorax differing from that of *hedleyi* in being stouter and in having the dorsal outline nearly straight in profile, the pronotum being convex only at the extreme anterior end and the mesonotum less impressed. Thoracic sutures very distinct but less impressed than in *hedleyi*. Mesonotum fully three times as broad as long. Petiole with very short peduncle, anterior surface of node more concave, its upper surface seen from above distinctly broader than long, with very convex sides. Constriction between the postpetiole and gaster somewhat deeper than in *hedleyi*, legs stouter.

Smooth and shining; mandibles shining, not striate but sparsely punctate, like the remainder of the body. Punctures on the head coarser than in *hedleyi*, and more abundant, especially on the cheeks and sides of the front. Clypeus subopaque, rugulose-punctate.

Hairs similar to those of *hedleyi* but coarser and of rather uneven length, pale yellow.

Rich ferruginous red, clypeus darker; tarsal claws, sutures of thorax and gaster, articulations of antennal funiculi dark brown, mandibular teeth black; legs and anal segments of gaster paler and more yellowish.

Female. Length nearly 5.5 mm.

Head a little longer than broad and nearly as broad in front as long, with prominent, depressed anterior corners, the sides converging posteriorly, with two transverse impressions, one half-way between the anterior corner and the eye and one at the eye. Eyes as small as in the worker, but more elongate. Mandibles with less abruptly incurved tips than in the worker and with only two indistinct teeth. Thorax more robust than in the worker, the pro- and epinotum with more convex sides and the pronotum more convex above, so that the mesonotum is more impressed in profile. From above the mesonotum is scarcely twice as broad as long. Petiole much larger than in the worker, with very short, slender peduncle, without ventral projection; node large, very convex in front, from above more than twice as broad as long, broader than the epinotum and nearly half as broad as the postpetiole. Gaster very much larger than in the worker, more than twice as long as broad, suboblong, flattened dorsoventrally.

Sculpture as in the worker, but the piligerous punctures, especially on the head, much coarser, almost foveolate and somewhat elongated on the sides of the front. Cheeks and sides of epinotum subopaque, finely rugulose-punctate.

Hairs coarser and longer, especially on the body, than in the worker.

Color more brownish ferruginous; mandibles, antennae, and legs more yellowish; pleurae, sides of petiole, and sutures of gaster brownish yellow.

Queensland: Herberton (type locality), Atherton and Cedar Creek (E. Mjöberg); Kuranda (Wheeler).

October 24, I found two fine colonies of this species in rotten logs. One comprised at least 400 workers, a single queen, with the abdomen greatly distended with eggs, and a large number of nearly mature larvae but no pupae. The other colony was somewhat less populous but also contained many larvae. The ants moved rather slowly in long files through the cracks in the wood, evidently endeavoring to

keep in close touch with one another by means of their antennae, after the manner of the Dorylinae. They stung severely for such small insects.

The worker of *O. mjöbergi* is readily distinguished from that of *hedleyi* by its paler color, shorter head, antennal scapes and funicular joints, the straight dorsal profile of the thorax, broader epinotum and petiole, deeper constriction between the postpetiole and gaster, and smooth, shining, and sparsely punctate mandibles.

Onychomyrmex doddi, sp. nov.

Plate 2, fig. 3–5.

Worker. Length: 2–2.5 mm.

Head subrectangular, about $\frac{1}{5}$ longer than broad, scarcely broader in front than behind, with nearly straight lateral and posterior borders and rounded posterior corners. Clypeus with broadly arcuate, finely denticulate anterior border, sinuate on the sides. Eyes very similar to those of the preceding species, situated about $\frac{3}{5}$ the distance from the anterior to the posterior border of the head. Mandibles with the long terminal tooth less abruptly bent inward, remaining teeth rather small. Antennal scapes $\frac{3}{4}$ as long as the head; first and terminal funicular joints fully twice as long as broad, remaining joints scarcely longer than broad. Thorax rather stout, shaped much as in *mjöbergi*, with straight, horizontal dorsal outline, the pronotum longer than broad, rising rather abruptly from the neck, but posteriorly flattened above, its sides only feebly convex. Mesonotum somewhat more than twice as broad as long. Thoracic sutures very distinct. Epinotum in profile with the base feebly and evenly convex and longer than the declivity which is sloping and distinctly concave. Petiole in profile with a short basal peduncle and prominent, compressed, somewhat translucent ventral projection; the node with subequal anterior and dorsal surfaces, both feebly convex; seen from above as long as broad, subrectangular, with rounded sides and straight, subequal anterior and posterior borders. Postpetiole as long as broad, very convex below and separated by a pronounced constriction from the gaster. Legs as in *mjöbergi*.

Smooth and shining, covered with small piligerous punctures, which are most abundant on the head and especially on the cheeks. Mandibles, clypeus, and cheeks opaque, the mandibles finely and sharply

striate and sparsely punctate, the clypeus densely transversely rugulose.

Pilosity pale yellow, much as in *hedleyi* but shorter.

Color also like that of *hedleyi*, deep castaneous, nearly black; mandibles, except the teeth, clypeus, and frontal carinae deep brownish red; antennae, legs, and tip of gaster yellowish brown; coxae and middle portions of femora and tibiae darker.

Female. Length nearly 4 mm.

Resembling the female of *mjöbergi* in form, but the head is proportionally broader behind and without lateral impressions; differing from the worker in the shape of the head, which is broadened in front, the feebly dentate, less curved mandibles and the stouter thorax and larger petiole, postpetiole, and gaster. The sides and dorsal surface of the pro- and epinotum are more convex than in the worker and the promesonotal and mesoëpinotal sutures are more impressed so that the dorsal outline is much less straight and continuous. Mesonotum not more than twice as broad as long. Petiole like that of the female *mjöbergi*, the peduncle very small, the node very large, convex and rounded in front and on the sides, with straight posterior border; seen from above it is only a little more than $1\frac{1}{2}$ times as broad as long, scarcely broader than the epinotum and more than half as broad as the postpetiole. The latter is separated by a very slight constriction from the gaster, which is large and shaped much as in the female *mjöbergi*.

Sculpture and color as in the worker, hairs considerably longer and coarser, especially on the postpetiole and gaster.

Queensland: Kuranda (Wheeler).

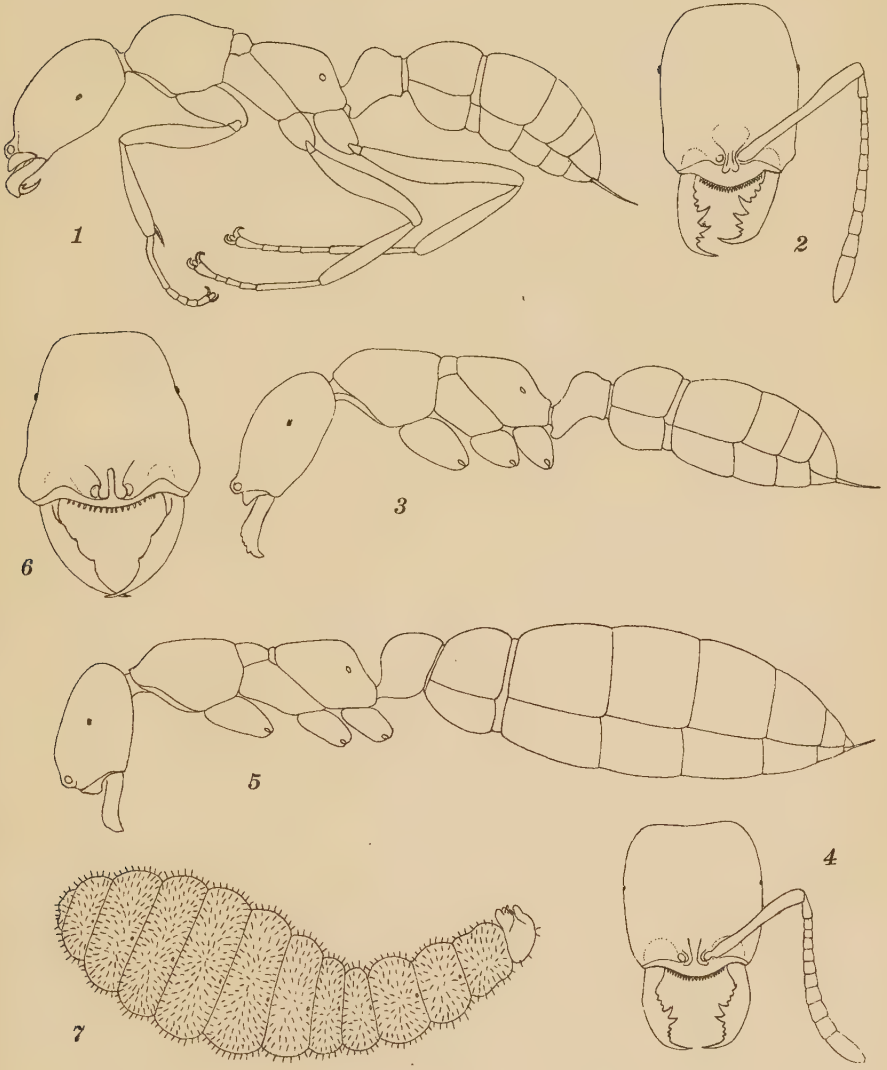
I found only one colony of this ant (November 1), consisting of a female and nearly 50 workers, but without larvae, in a small log in a damp, shady spot in the dense "scrub."

The worker is readily distinguished from both *hedleyi* and *mjöbergi* by its smaller size and less abruptly curved mandibles; from *mjöbergi* by its color, longer head, striated mandibles and finer pilosity; from *hedleyi* by the straight dorsal outline of the thorax and less convex pronotum, shorter petiole, scapes, and funicular joints.

PLATE 1.

PLATE 1.

1. *Onychomyrmex hedleyi* Emery. Worker, lateral view.
2. Head of same; dorsal view.
3. *O. mjöbergi* Forel. Worker, lateral view.
4. Head of same, dorsal view.
5. *O. mjöbergi* Forel. Female, lateral view.
6. Head of same, dorsal view.
7. Adult larva of *O. mjöbergi*, lateral view.



W. M. WHEELER, DEL.

The following Publications of the Museum of Comparative Zoölogy are in preparation:—

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
E. L. MARK. On Arachnactis.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
K. BRANDT. The Thalassicolae.
O. CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
H. L. CLARK. The Ophiurans.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to LIV. and Vols. LVIII. and LIX.; of the MEMOIRS, Vols. I. to XXIX., and also Vols. XXXI. to XXXIV., XXXVI. to XXXVIII., XL. to XLII., and XLIV.

Vols. LV. to LVII., LX. and LXI. of the BULLETIN, and Vols. XXX., XXXV., XXXIX., XLIII., XLV. to XLIX. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Officers of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation:—

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

These publications are issued in numbers at irregular intervals. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

Ants Collected in British Guiana by the Expedition of the American Museum of Natural History during 1911.

By William Morton Wheeler.

BULLETIN OF THE

AMERICAN MUSEUM OF NATURAL HISTORY,

Vol. XXXV, Art. I, pp. 1–14.

New York, February 21, 1916.

(*Continued from 3d page of cover.*)

VOL. XIII. ANTHROPOLOGY (not yet completed).

**Jesup North Pacific Expedition, Vol. IX.*

PART I.— The Yukaghir and the Yukaghirized Tungus. By Waldemar Jochelson. Pp. 1–133, pll. i–vii, 1 map, 1910. Price, $3.40.

VOL. XIV. ANTHROPOLOGY.

**Jesup North Pacific Expedition, Vol. X.*

PART I.— Kwakiutl Texts. Second Series. By Franz Boas and George Hunt. Pp. 1–269. 1906. Price, $2.80.

PART II.— Haida Texts. By John R. Swanton. Pp. 271–802. 1908. Price, $5.40.

MEMOIRS.

NEW SERIES, VOL. I.

PART I.— Crania of Tyranosaurus and Allosaurus. By Henry Fairfield Osborn, pp. 1–30, pll. i–iv and text figures 1–27. 1912.

PART II.— Integument of the Iguanodont Dinosaur Trachodon. By Henry Fairfield Osborn. Pp. 31–54, pll. v–x, and text figures 1–13. 1912. Parts I and II are issued under one cover. Price, $2.00.

PART III.— Craniometry of the Equidæ. By Henry Fairfield Osborn. Pp. 55–100, text figures 1–17. 1912. Price, 75 cents.

PART IV.— Orthogenetic and Other Variations in Muskoxen, with a Systematic Review of the Muskox Group, Recent and Extinct. By J. A. Allen. Pp. 103–226, pll. xi–xviii, text figures 1–45, 1913. Price $2.50.

PART V.— The California Gray Whale (*Rhachianectes glaucus* Cope). By Roy C. Andrews. Pp. 229–287, pll. xix–xxvii, text figures 1–22. 1914. Price, $2.00.

ETHNOGRAPHICAL ALBUM.

Jesup North Pacific Expedition.

Ethnographical Album of the North Pacific Coasts of America and Asia. Part 1, pp. 1–5, pll. 1–28. August, 1900. Sold by subscription, price, $6.00.

BULLETIN.

The matter in the 'Bulletin' consists of about 24 to 36 articles per volume, which relate about equally to Geology, Palæontology, Mammalogy, Ornithology, Entomology, and (in former volumes) Anthropology, except Vol. XI, which is restricted to a 'Catalogue of the Types and Figured Specimens in the Palæontological Collection of the Geological Department,' and Vols. XV, XVII, and XVIII, which relate wholly to Anthropology. Volume XXIII and the later volumes contain no anthropological matter, which is now issued separately as 'Anthropological Papers.'

Volume	I, 1881–86	Out of print	Volume	XVII, Part V, 1907	Price, $1.25
"	II, 1887–90	Price, $4.75	"	XVIII, " I, 1902	" 2.00
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ANTHROPOLOGICAL PAPERS.

Vols. I–XIV, 1908–1914.

AMERICAN MUSEUM JOURNAL.

The 'Journal' is a popular record of the progress of the American Museum of Natural History, issued monthly, from October to May inclusive. Price, $1.50 a year. Volumes I–XIV, 1900–1914.

*The Anatomy of the Common Squid. By Leonard Worcester Williams. Pp. 1–87, pll. i–iii, and 16 text figures. 1909.

*Chinese Pottery of the Han Dynasty. By Berthold Laufer. Pp. 1–339, pl. i–lxxv, and 55 text figures. 1909.

For sale at the Museum.

*Published by E. J. Brill, Leiden, Holland. Not on sale at the Museum. American Agent, G. E. Stechert, 129 West 20th Street, New York City.

BULLETIN

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY.

VOLUME XXXV, 1916.

59.57,96(88)

Article I.—ANTS COLLECTED IN BRITISH GUIANA BY THE EXPEDITION OF THE AMERICAN MUSEUM OF NATURAL HISTORY DURING 1911.[1]

By William Morton Wheeler.

Within recent years the majority of ants described from South America have come from Brazil, Paraguay, Argentina and Colombia, and comparatively little material has found its way into collections from the Guianas, which furnished the early naturalists with so many specimens. This is, of course, explained by the large number of resident and visiting collectors who have been recently working in other parts of South America, especially in Brazil and Argentina. I was glad, therefore, to have an opportunity to study the ants collected during 1911 in British Guiana by Dr. H. E. Crampton and Dr. F. E. Lutz of the American Museum of Natural History. The course of the expedition was from Georgetown through Rockstone, Tumatumari, Kangaruma, Tukeit, Kaieteur, Chenapown, Saveritik, Parmak to Kamawa-wong (Roraima) and return by the same route. The collection contains several new and interesting species, though the greater number are well known. This was to be expected, because so many members of the neotropical ant-fauna have a very wide distribution, not only in northern South America but also in Central America and tropical Mexico.

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University. No. 105.

Family FORMICIDÆ.

Subfamily PONERINÆ.

1. **Paraponera clavata** *Fabr.* Several workers taken at Tukeit and Kaieteur on the forest floor (Lutz) and one from near the Wailang River (Crampton).

2. **Ectatomma tuberculatum** *Olivier.* Numerous workers from Kaieteur and Tumatumari; at Kaieteur they were most numerous in the forest where it meets the savannah (Lutz); also workers from near the Karanang River (Crampton).

3. **Ectatomma quadridens** *Fabr.* Numerous workers from Georgetown and Kaieteur (Crampton and Lutz) and from the former locality (J. J. Welsh).

4. **Ectatomma strigosum** *Emery* var. **lugens** *Emery.* A single worker from Kaieteur (Lutz) agreeing well with Emery's description.

5. **Ectatomma** (**Gnamptogenys**) **mordax** *F. Smith.* Numerous workers and one winged female from Kaieteur (Lutz).

6. **Ectatomma** (**Gnamptogenys**) **tortuolosum** *F. Smith.* Workers from Rockstone (Lutz).

7. **Neoponera villosa** *F. Smith* subsp. **inversa** *F. Smith.* Three workers from Kaieteur (Lutz).

8. **Neoponera apicalis** *Latr.* Two workers from Tukeit and one from Kaieteur (Lutz).

9. **Neoponera obscuricornis** *Emery.* A single worker from Kaieteur (Lutz), attached to a leaf and with a fungus (*Cordyceps unilateralis* Tul.) growing out of the back of its head.

10. **Neoponera unidentata** *Mayr.* Two workers from Kaieteur (Lutz).

11. **Neoponera carinulata** *Roger.* A single worker from Tukeit (Lutz).

12. **Neoponera commutata** *Roger.* Several workers and a partially deälated female from Kaieteur, Potaro Landing and Tukeit (Lutz). The specimen from Tukeit is accompanied by a large termite worker labelled "this ant's prey."

13. **Pachycondyla crassinoda** *Latr.* Seven workers from Kaieteur and Tukeit (Crampton and Lutz).

14. **Euponera** (**Mesoponera**) **lævigata** *F. Smith.* A single worker from Kaieteur (Lutz).

15. **Euponera (Mesoponera) constricta** *Mayr.* Several workers from Kaieteur and Tukeit (Crampton and Lutz).

16. **Euponera (Trachymesopus) stigma** *Fabr.* Specimens of all three phases from Kaieteur and Tukeit (Lutz).

17. **Ponera opaciceps** *Mayr.* Five workers from Kaieteur and a deälated female from Tukeit (Lutz).

18. **Anochetus mayri** *Emery.* A single worker from Tukeit (Lutz).

19. **Anochetus (Stenomyrmex) emarginatus** *Fabr.* Two workers of the typical form of the species from Rockstone and Tumatumari (Lutz).

20. **Odontomachus chelifer** *Latr.* Two workers taken in the forest near Tururaparu — a small creek west of Chenapown (Crampton).

21. **Odontomachus hastatus** *Fabr.* A worker and female taken at Kaieteur (Lutz).

22. **Odontomachus hæmatoda** *L.* A worker and deälated female from Kaieteur (Lutz).

Subfamily Dorylinæ.

23. **Eciton burchelli** *Westwood.* Numerous workers from Parmak, Brazil. They were part of an "army" on the move in a large area of forest surrounded by savannah, five miles west of the Cotinga River, 3° north latitude; altitude, 2800 feet (Crampton).

Subfamily Myrmicinæ.

24. **Pseudomyrma gracilis** *Fabr.* Half a dozen workers of the typical form of this species from Georgetown, Rockstone and Kaieteur, B. G. and New Amsterdam, Paramaribo, D. G. (Lutz).

25. **Pseudomyrma gracilis** *Fabr.* var. **dimidiata** *Roger.* A deälated female from Tumatumari B. G. and a worker from New Amsterdam, D. G. (Lutz).

26. **Pseudomyrma nigrocincta** *Emery.* A single small deälated female from Kaieteur (Lutz).

27. **Solenopsis geminata** *Fabr.* A single small worker from Tumatumari.

28. **Solenopsis geminata** *Fabr.* subsp. **sævissima** *F. Smith.* Three workers from Georgetown (Crampton).

29. **Solenopsis brevicornis** *Emery.* A single worker from Tumatumari (Lutz).

30. **Pheidole cramptoni** sp. nov.

Soldier. Length 3–3.5 mm.

Allied to *Ph. subarmata* Mayr and *cornutula* Emery. Head rather flat, subrectangular, about $\frac{1}{5}$ longer than broad, slightly broader in front than behind, with deeply and acutely excised occipital border, nearly straight, subparallel sides and very prominent anterior corners. Occipital groove deep and narrow. Gular teeth very prominent and rather pointed. Eyes small, situated a little less than $\frac{1}{4}$ the distance from the anterior to the posterior corners of the head. Mandibles very convex, with two apical teeth. Clypeus very short, flattened, but with a short, prominent carina behind, the anterior border nearly straight. Frontal area impressed, subtriangular, without a median carinula. Frontal carinæ short, each anteriorly forming a prominent, suberect, tooth-like lobe, diverging behind to form the indistinct mesial borders of very shallow scrobe-like impressions for the antennæ. Antennæ short and slender; scapes reaching to the middle of the head; funicular joints 2–7 broader than long, club scarcely longer than the remainder of the funiculus, its two basal joints of subequal length and only a little longer than broad. Thorax small, through the humeri about half as broad as the head; pro- and mesonotum forming a single mass, transversely flattened dorsally between the humeri which are prominent and bluntly angular; in profile the mesonotum is convex, without a torus behind, marginate on the sides and falling rather abruptly to the pronounced meso-epinotal constriction. Epinotum small, much narrower and lower than the promesonotum; its base and declivity subequal in profile, sloping between the spines, which are rather stout, moderately long and acute, nearly as long as the base of the epinotum, longer than broad at their bases, but shorter than their distance apart, directed upward, outward and backward. Petiole from above violin-shaped, a little more than twice as long as broad, broader behind than in front, the node rather low, compressed anteroposteriorly, with transverse, broadly excised superior border. Postpetiole only a little broader than the petiole, subrectangular from above, a little broader in front than behind and only slightly broader than long. Gaster as large as the head, elongate elliptical, with straight anterior border. Femora strongly swollen in the middle.

Smooth and shining: mandibles very sparsely punctate. Anterior $\frac{3}{4}$ of head sharply but not densely, longitudinally rugose, with feeble indications of interrugal reticulation, posterior corners of head with very sparse and rather coarse, piligerous punctures. Epinotum and sides of petiole and postpetiole rather indistinctly and irregularly rugose. Gaster and legs with very fine, sparse, piligerous punctures.

Hairs pale yellow, rather fine but uneven, moderately long, suberect on the body, legs and antennal scapes.

Chestnut brown; antennæ and tibiæ paler; tarsi, mandibles and anterior $\frac{2}{3}$ of head pale brownish yellow; borders of mandibles, frontal carinæ, clypeal border and a spot on the clypeal carina, dark brown.

Worker. Length about 2 mm

Head, excluding the mandibles, a little longer than broad, subelliptical; eyes prominent, just in front of the middle of its sides. Mandibles with several small subequal teeth. Clypeus with straight anterior border, rather convex, ecarinate. Antennal scapes reaching a little beyond the posterior corners of the head. Thorax similar to that of the soldier, but without prominent, angular humeri and the base

of the epinotum longer in proportion to the declivity, the spines well-developed, but more slender, nearly as long as their distance apart at the base. Petiole slender, more than 3 times as long as broad, with small, rounded, entire node. Postpetiole half again as broad as the petiole, a little longer than broad, subglobular. Gaster with very straight, transverse anterior border.

Sculpture and pilosity very similar to those of the soldier, but the head not rugose in front, except at the extreme anterior corners, and the rugosity of the epinotum, petiole and postpetiole very feeble.

Chestnut brown; antennæ, mandibles, clypeus and legs paler and more yellowish.

Described from 10 soldiers and 12 workers taken at Kaieteur (Lutz).

This species is closely related to *Ph. subarmata* and *cornutula*, being about midway between the two in the shape of the head and frontal carinæ of the soldier, but the thorax is very different, as neither of the species mentioned has prominent, angular humeri or such a small postpetiole. The worker of *cramptoni* has prominent epinotal spines, which are lacking in *subarmata* and *cornutula* and the thorax is more robust and has the promesonotum transversely flattened above.

31. **Pheidole biconstricta** *Mayr.* Numerous soldiers and workers from Tukeit (Crampton and Lutz).

32. **Pheidole jelskii** *Mayr.* Numerous soldiers and workers from Rockstone (Lutz).

33. **Pheidole exigua** *Mayr.* Soldiers and workers from Tukeit and Kaieteur (Lutz).

34. **Pheidole mimula** sp. nov.

Soldier. Length 2.3 mm.

Related to *Ph. punctatissima* Mayr and *anastasii* Emery. Head very large, a little longer than broad, slightly narrower in front than behind, with deeply excised posterior border, feebly convex sides and rounded posterior corners, without traces of scrobes on the sides. Occipital groove moderately deep; eyes rather large and convex, elliptical, situated $\frac{1}{4}$ the distance from the anterior to the posterior corners of the head. Mandibles convex, with two apical teeth. Clypeus short, rather flat, ecarinate, its anterior margin very feebly bidentate and scarcely excised in the middle. Frontal area distinct, impressed, subtriangular. Frontal carinæ very short. Antennæ rather long and slender, the scapes reaching to nearly $\frac{3}{4}$ the distance between the eyes and the posterior corners of the head; joints 2–8 of the funiculi as long as broad; two basal joints of club each more than twice as long as broad and together equalling the terminal joint. Thorax small, through the pronotum less than half as broad as the head. There is a distinct transverse line-like impression between the pro- and mesonotum and another broader one across the mesonotum, so that the thorax resembles that of *Ph. triconstricta* Mayr in profile. The humeri are neither angular nor prominent, the posterior portion of the mesonotum falls as an abrupt declivity to the mesoëpinotal constriction. Epinotum small, much lower than the promesonotum, with subequal base and declivity, the former feebly convex in profile, the latter concave. Spines slender, pointed, about half as long as the base of the

epinotum, directed upward, backward and slightly outward; between them the surface of the epinotum forms a gradual, uninterrupted slope. Petiole about twice as long as broad, broadest behind through the node which is rounded and subconical, not compressed. Postpetiole broader than the petiole, somewhat broader than long, its sides bluntly but distinctly angular just in front of the middle. Gaster much smaller than the head, elliptical, with rounded anterior border. Legs rather long, femora incrassated in the middle.

Mandibles smooth and shining, very sparsely punctate. Clypeus, head, thorax, pedicel and basal $\frac{3}{4}$ of first gastric segment opaque. Clypeus obscurely punctate-rugulose. Head, thorax, pedicel and anterior portion of first gastric segment very finely and densely punctate; head also feebly longitudinally rugulose on the front and cheeks; its posterior corners with a few shallow, elongate foveolæ. Posterior fourth of first gastric segment and all the remaining segments shining. Legs subopaque.

Hairs yellow; on the head, thorax and gaster sparse, erect and blunt. Appendages with very fine pale pubescence, without erect hairs.

Testaceous; head slightly darker and more reddish; inner borders of mandibles and anterior border of clypeus and head dark brown or blackish.

Described from two specimens taken at Tukeit (Lutz).

This species belongs to a very complex and difficult group and seems to be most closely related to *Ph. punctatissima* and *anastasii*, but differs from both in its smaller size, much longer antennæ, very differently shaped promesonotum, narrower and less distinctly conulate postpetiole and peculiar pilosity, the hairs being blunt on the body, instead of pointed, and absent on the scapes and legs.

35. **Pheidole cataractæ** sp. nov.

Soldier. Length: 2.5 mm.

Related to *Ph. dimidiata* Emery and *orbica* Forel. Head large, as broad as long, a little broader behind than in front, with straight sides, broadly rounded posterior corners and deep occipital excision extending forward into a deep and rather broad occipital groove. Teeth on the anterior border of the gula large and projecting. Eyes moderately large and convex, situated a little less than $\frac{1}{3}$ the distance from the anterior to the posterior corners of the head. Mandibles convex, with two apical teeth and two basal denticles. Clypeus short, flat, ecarinate, the anterior border with a small but distinct median excision, sinuate on the sides. Frontal area large, impressed, semicircular. Frontal carinæ diverging behind, continued back to the posterior third of the head as a ruga forming on each side the mesial border of a very faint, narrow scrobe-like impression. Antennæ rather slender; scapes reaching fully $\frac{3}{5}$ the distance between the eyes and posterior corners of the head, funicular joints 2–7 as long as broad; the two basal joints of the club subequal, fully twice as long as broad, together as long as the terminal joint. Thorax rather robust anteriorly through the humeri which are prominent but not angular. Promesonotal suture distinct and impressed; base of mesonotum convex, sloping rather gradually behind

to the deep mesoëpinotal constriction. Epinotum in profile with straight base and concave declivity, the former distinctly longer than the latter; spines slender, short and acute, shorter than their distance apart at the base, directed upward. Petiole slender, fully 3 times as long as broad, slightly broader behind through the node, with straight sides, the node rather low, scarcely compressed anteroposteriorly, with straight, entire superior border. Postpetiole small, a little broader than the petiole and as long as broad, trapezoidal, broadest through the anterior border, with distinct anterior corners. Gaster much smaller than the head, elliptical, with rounded anterior border. Legs rather long; femora distinctly enlarged in the middle.

Smooth and shining; mandibles coarsely and sparsely punctate, coarsely rugose at the base. Clypeus smooth in the middle, longitudinally rugulose on the sides. Anterior $\frac{3}{5}$ of head sharply but not very densely, longitudinally rugose, the interrugal spaces more or less reticulate-punctate; posterior portion of head glabrous, with sparse piligerous punctures. Pronotum smooth and shining; meso- and epinotum subopaque, densely and uniformly punctate. Gaster and nodes of petiole and postpetiole smooth and shining, peduncle of petiole densely punctate.

Hairs whitish, very long, rather abundant but uneven, suberect both on the body and appendages and as long on the scapes and legs as on the thorax and gaster.

Black; antennæ castaneous; legs slightly paler, tarsi yellowish; mandibles, except their borders, clypeus and cheeks deep brownish red.

Worker. Length 2 mm.

Head a little longer than broad, regularly elliptical, without posterior corners, evenly and convexly narrowed behind to the occipital articulation which is distinctly marginate. Eyes in front of the middle of the sides. Mandibles with numerous small but very unequal denticles, apical tooth not enlarged nor lengthened. Clypeus convex, with rounded, slightly projecting anterior border. Antennæ long and slender, the scapes extending about $\frac{1}{4}$ of their length beyond the occipital border of the head. Thorax similar to that of the soldier, but more slender and the epinotum without spines, each of which is represented merely by the angle between the base and declivity in profile. Petiole and postpetiole also similar to those of the worker but the latter small and globular, scarcely broader than the petiole. Gaster smaller than the head. Legs slender.

Smooth and shining; mandibles sparsely punctate; mesonotum and epinotum densely punctate and subopaque.

Hairs whitish, suberect, abundant and conspicuously long, as long on the appendages as on the body; even the funiculi, excluding the clubs, bear long and conspicuous hairs.

Black or very dark brown; antennæ, and legs paler brown; mandibles and tarsi yellowish.

Described from three soldiers and five workers taken at Kaieteur (Lutz).

This species is evidently related to *Ph. dimidiata* and *orbica*, but is easily distinguished from both in the soldier phase by the much longer antennæ, more slender and upwardly directed epinotal spines, much longer and narrower petiole, longer hairs, etc. The worker of *cataractæ* has a very different head, lacking the posterior corners, the antennæ and legs are much longer than in *dimidiata* and *orbica* and the pilosity is much longer and more abundant, especially on the appendages.

36. **Monomorium pharaonis** *L.* Several workers taken on board the steamship "Korona" (Lutz).

37. **Wasmannia auropunctata** *Roger.* Numerous workers and a single winged female from Tukeit (Lutz and Crampton).

38. **Wasmannia subpolita** sp. nov.

Worker. Length: 2–2.2 mm.

Head as broad as long, distinctly broader behind than in front, with very feebly concave posterior border and rather convex sides; the posterior orbits of the rather large eyes at the median transverse diameter of the head. Mandibles with oblique terminal borders, armed with four subequal teeth. Clypeus large, convex, with evenly rounded, entire, projecting anterior margin. Frontal area small, crescentic. Frontal carinæ diverging behind, continued nearly to the posterior corners of the head, distinct in front but very feeble and more or less obsolete behind, forming the mesial borders of shallow, indistinct antennal scrobes. The lateral border of each scrobe is formed by a delicate ridge running just above the eye and also growing very faint posteriorly. Antennal scapes reaching to the posterior corners of the head; club of funiculus distinctly 3-jointed, its basal joint nearly as long as the second, but more slender; both together shorter than the enlarged terminal joint; first funicular joint fully 3 times as long as broad; second and seventh joints as long as broad; joints 3–6 a little broader than long. Thorax rather robust, but much narrower than the head, broadest through the pronotum, which is a little longer than broad, with rounded sides, flattened above and marginate along the raised border just back of the neck, the margination running down on each side to the insertion of the fore coxa. Mesoëpinotal constriction distinct; epinotum from above as broad as long, with inflated sides; in profile the base is convex in front, flattened behind, longer than the sloping, concave declivity. The spines are small and acute, as long as the distance between their bases, directed upward and outward and slightly backward. Petiole less than twice as long as broad, broadest behind through the rounded node, which rises rather abruptly from the peduncle; postpetiole rounded, a little broader than long and a little broader than the postpetiole, its node convex but lower than the petiolar node. Gaster about the size of the head, elongate elliptical, with rather straight anterior border.

Subopaque; delicately reticulate rugose; mandibles, clypeus, upper surface of head, nodes of petiole and postpetiole, gaster and appendages smooth and shining.

Hairs white, glistening; on the body very sparse, short, erect and slender but blunt at the tips, still shorter and oblique on the legs and scapes.

Honey yellow throughout, with only the mandibular teeth and articulations of the appendages brown and the eyes black.

Described from numerous workers taken at Tukeit and Kaieteur (Lutz) and Kauwa Creek, Roraima (Crampton).

This species at first sight may be readily mistaken for a *Leptothorax*, but it is evidently referable to the genus *Wasmannia*, though it exhibits many of the generic peculiarities in a feeble or obliterated condition. Among

the described species it most closely approaches *W. iheringi* Forel of Brazil, but is very different in the shape of the thorax and in the peculiar and very feeble sculpture.

39. **Daceton armigerum** *Perty.* Several workers from Tukeit (Lutz) and a winged female from an unrecorded locality in British Guiana (R. W. Crew).

40. **Basiceros singularis** *F. Smith.* A worker from Tukeit and two workers and a deälated female from Kaieteur (Lutz). This seems to be the first time this extraordinary ant has been taken since the types were captured by Bates at Ega, Brazil. The specimens from British Guiana agree well with Smith's figures if due allowance be made for the inaccuracies that characterize all his illustrations.

41. **Sericomyrmex lutzi** sp. nov.

Worker. Length 3–3.5 mm.

Head cordate, narrowed in front, a little broader than long, the posterior corners prominent and angular but not acute, the posterior border angularly excised, the lateral borders feebly convex; scrobes for the antennæ distinct in front, not carried to the posterior corners but fading out about half way between them and the dilated frontal carinæ. Genal carinæ sharp, extending a little further back than the eyes. Eyes rather large, moderately convex; their posterior orbits about $\frac{1}{3}$ the distance between the anterior and posterior corners of the head. Mandibles rather long, their external borders concave in the middle, their terminal borders armed with 7 or 8 large teeth. Clypeus rather flat in the middle, its anterior border transverse, entire and nearly straight. Antennal scapes reaching to a little more than $\frac{2}{3}$ the distance between the eyes and the posterior corners of the head. Pronotum with three blunt tubercles, the median slightly larger than the others which form the lateral corners of the segment. Inferior pronotal angle with a flat, pointed tooth. Mesonotum with a pair of pointed, conical tubercles at its anterior corners, much larger than those on the pronotum, a little longer than broad at their bases, posteriorly with a pair of much smaller and blunter, approximated tubercles. Mesoëpinotal constriction short and pronounced. Epinotum short, as broad as long; the base with a pair of low blunt longitudinal ridges, in profile convex in front, sloping behind, very distinctly longer than the concave declivity. Petiole from above subrectangular, longer than broad, a little broader in front than behind, the node formed by a couple of small, blunt tubercles with rather straight anterior and concave posterior slopes in profile. Postpetiole about $1\frac{1}{2}$ times as broad as the petiole and nearly twice as broad as long, triangular in profile, its upper surface longitudinally impressed in the middle. First gastric segment subrectangular, a little longer than broad, with four blunt longitudinal ridges, two on the dorsal surface and one on each side forming the lateral borders. The latter are short and rather indistinct. Legs long and stout.

Mandibles shining, sparsely and coarsely punctate, with a few short, coarse striæ at the extreme base and near the terminal border. Remainder of body opaque, densely punctate-rugulose and covered with minute piligerous tubercles.

Covered, apart from the mandibles, with a dense layer of fine, grayish yellow hairs, partly forming a long, dense appressed pubescence and partly, on the dorsal surface of the body, funiculi and extensor surfaces of the legs, a sparser layer of longer, nearly reclinate and straight hairs.

Deep ferruginous red; legs scarcely paler; mandibles bright red, their terminal borders and the anterior border of the clypeus and head black.

Female. Length 5 mm.; wings 7 mm.

Differing from the worker in having the antennal scrobes more distinct behind, the mesonotum flattened above and without tubercles and the ridges on the first gastric segment longer and curved ventrally behind. Wings heavily infuscated; opaque, with dark brown veins.

Male. Length 4 mm.

Head, including the eyes, a little broader than long, narrowed behind, with straight, distinct posterior and postocular borders; cheeks short but distinct; eyes very large and convex; ocelli rather far apart. There are distinct but short scrobe-like depressions at the sides. Frontal carinæ short. Mandibles long and slender with three large apical and several small basal teeth. Antennæ slender, 12-jointed; scapes as long as the funiculi without their terminal joint; funiculi with a distinct 4-jointed club, the three basal joints of which are subequal and together longer than the terminal joint; first funicular joint nearly twice as long as broad, joints 2–7 distinctly longer than broad. Thorax rather robust, broader than the head, without tubercles; mesonotum without distinct Mayrian furrows; scutellum with a median longitudinal impression. Petiole from above broadest in the middle, the posterior lateral borders excised. Postpetiole similar to that of the worker. Gaster of the usual structure in male *Attini*, without longitudinal ridges on the first segment. Cerci distinct; genitalia very small and retracted. Legs slender.

Sculpture much as in the worker, but the mandibles less smooth and shining, very finely and densely striate. Gaster coarsely reticulate and sparsely punctate.

Both the pubescence and long, oblique hairs much less abundant than in the worker and female so that the surface of the integument is clearly visible. Legs and scapes with very fine, appressed pubescence, appearing naked under a low magnification.

Color more brownish than in the worker and female; head dark brown; antennæ, mandibles and legs brownish yellow. Wings colored as in the female.

Described from numerous workers and females and a single male from small "island" of forest in the savannah near Kauwa Creek, Roraima

The relationship of this to the nine other known species of *Sericomyrmex* may best be shown by slightly modifying Forel's recent table for the workers and females of the genus and inserting the new form·

1. Pubescence woolly, whitish, resembling mold; erect or reclinate hairs absent. ♀ 5.7 mm. Brazil. ..... *burchelli* Forel
   Suberect or reclinate hairs present, more or less abundant; aspect not moldy. . .2
2. Head with scrobes on each side for the accommodation of the antennæ. 3
   Scrobes absent. ♀ 4.5 mm. Brazil. ..... *mayri* Forel
3. Scrobes complete and very distinct. 4
   Scrobes incomplete or partially indistinct. 5

4. First gastric segment not marginate on the sides; petiole unarmed. ☿ 3.5–3.8 mm. Brazil. ..... *scrobifer* Forel
   First gastric segment marginate on the sides, petiole bidentate ☿ 8 mm. Brazil. *opacus* Mayr
5. Mesonotum in front with a pair of elevated horns. 6
   Mesonotum in front only with tubercles. 7
6. Epinotum bidentate; horns of mesonotum long and spiniform. ☿ 3.5–4 mm. Brazil. ..... *saussurei* Emery
   Epinotum unarmed; with two longitudinal ridges only; horns of mesonotum smaller, conical. ☿ 3–3.5 mm. ♀ 5 mm. British Guiana ..... *lutzi* sp. nov.
7. Pile of body and appendages reclinate or very oblique. Gaster scarcely marginate on the sides. ☿ 3.3–3.7 mm. Colombia. ..... *diego* Forel
   Pile suberect, first gastric segment anteriorly marginate on the sides. 8
8. Mesonotum bidentate behind. ☿ 2.7 mm. Brazil. ..... *parvulus* Forel
   Mesonotum obtusely bituberculate behind. Larger. 9
9. Scrobe very indistinct. ☿ 4.5 mm. Trinidad. ..... *urichi* Forel
   Scrobe rather distinct. ☿ 3.5 mm. Mexico. ..... *aztecus* Forel

42. **Apterostigma mayri** *Forel.* Several workers from Tukeit (Lutz).

43. **Apterostigma urichi** *Forel,* var. A single worker from Kaieteur (Lutz) is considerably darker than typical specimens from Trinidad and covered with a bluish bloom. It may represent a new variety, but the material is not sufficient to justify the introduction of another name.

44. **Trachymyrmex farinosa** *Emery.* A single worker from Tukeit (Lutz).

45. **Trachymyrmex urichi** *Forel* subsp. **fuscus** *Emery,* var. Eight workers from the savannah 10 miles west of Parmak and the Cotinga River, altitude about 3000 ft. (Crampton). These agree closely with cotype specimens but are somewhat darker and covered with a whitish bloom.

46. **Acromyrmex emilii** *Forel.* Numerous workers from Kaieteur and Amatuk (Lutz).

47. **Atta sexdens** *L.* Workers of the typical form from Rockstone (Lutz).

48. **Atta sexdens** *L.* subsp. **lævigata** *F. Smith.* Fine series of workers from Rockstone (Lutz) and from Saveritik forest (Crampton). The latter are darker than the former.

49. **Atta cephalotes** *L.* Workers from Tumatumari (Crampton) and Tukeit (Lutz).

50. **Cryptocerus oculatus** *Spinola.* Two workers from Kaieteur (Lutz).

51. **Cryptocerus spinosus** *Mayr.* Two workers from Rockstone and Potaro Landing (Lutz).

52. **Cryptocerus maculatus** *F. Smith.* A worker minor from Tumatumari (Lutz).

53. **Cryptocerus pusillus** *Klug.* A worker minor from Georgetown (Lutz).

54. **Cryptocerus (Cephalotes) atratus** *L.* Several workers from Georgetown and Rockstone (Lutz).

55. **Crematogaster acuta** *Fabr.* Four workers from Kaieteur (Lutz).

56. **Crematogaster quadriformis** *Roger.* A single dark-colored worker from Kaieteur (Lutz).

57. **Crematogaster longispina** *Emery* subsp. **tenuicula** *Forel.* A large number of workers, Tukeit and Kaieteur (Lutz), agreeing closely with cotype specimens from Pará, Brazil.

58. **Crematogaster limata** *F. Smith* subsp. **ludio** *Forel.* Many worker specimens from Kaieteur, Tukeit and Tumatumari, B. G. and Fort Amsterdam, D. G. (Lutz) agreeing very closely with Forel's description, except in the shape of the petiole, which is distinctly narrowed in front.

59. **Crematogaster limata** *F. Smith* subsp. **parabiotica** *Forel.* Several workers from Tukeit (Lutz) agreeing very closely with cotypes from Colombia.

60. **Crematogaster brevispinosa** *Mayr* var. **tumulifera** *Emery.* Numerous workers found nesting in old moth cocoons at Georgetown (Lutz) agree with this variety except in being rather dark in color and in having the convex base of the epinotum striated. As Forel distinguishes no less than 19 varieties and subspecies of *brevispinosa* I feel disinclined to add another name till the whole group can be carefully studied with abundant material.

Subfamily Dolichoderinæ.

61. **Dolichoderus attelaboides** *Fabr.* One worker from Tukeit (Lutz) and one from Bartica (Geo. Engelhardt).

62. **Dolichoderus decollatus** *F. Smith.* Two workers from Kaieteur (Lutz).

63. **Dolichoderus (Hypoclinea) bidens** *Latr.* Several workers from Kaieteur (Lutz) and one from Bartica (Geo. Engelhardt).

64. **Dorymyrmex pyramicus** *Roger.* Two workers from Tumatumari (Lutz).

65. **Azteca instabilis** *F. Smith.* Numerous workers from Kaieteur (Lutz).

66. **Azteca jelskii** *Emery.* Numerous workers from Tukeit (Lutz).

67. **Azteca sericea** *Mayr.* Several media and minor workers from Kaieteur (Lutz).

Subfamily CAMPONOTINÆ.

68. **Brachymyrmex patagonicus** *Mayr.* More than a dozen workers from Kaieteur and six deälated females from Tukeit (Lutz).

69. **Prenolepis (Nylanderia) longicornis** *Fabr.* A few workers taken on board the steamship "Korona."

70. **Prenolepis (Nylanderia) cæciliæ** *Forel.* Numerous workers and three winged females from Kaieteur (Lutz).

71. **Prenolepis (Nylanderia) lietzi** *Forel.* Four workers from Kauwa Creek, Roraima (Crampton).

72. **Gigantiops destructor** *Fabr.* Several workers and a deälated female from Kaieteur, Tukeit and Tumatumari (Lutz).

73. **Dendromyrmex fabricii** *Roger.* Three workers and a deälated female from Tukeit (Lutz), together with their small carton nest on the under side of a leaf. The worker agrees very closely with Roger's description based on specimens from Surinam. The female measures about 7 mm. and very closely resembles the worker except that the basal segments of the gaster are darker and the legs are deep red instead of testaceous.

74. **Dendromyrmex fabricii** *Roger* var. **rufescens** var. nov.

Worker. Differing from the typical form in color, the whole body and the appendages being ferruginous red, the gaster considerably darker and more brownish, with the posterior portions of each segment blackish and the clypeus, mandibles and anterior border of the head more yellowish. The appressed pubescence on the gaster is a little sparser than in the typical form, so that the punctate integument is more clearly visible.

Numerous specimens from Tukeit (Lutz).

75. **Dendromyrmex nidulans** *F. Smith* var. **nigripes** var. nov.

Worker. Differing from the typical form in having the legs and antennal funiculi black or very dark brown, with only the terminal tarsal joints and the tip of the last funicular joint reddish. The gaster is golden brown as in typical specimens from Brazil.

Female. Differing from the female of typical *nidulans* in the same characters as the worker. The wings have the veins bordered with dark brown as in the type.

Several workers and a single female from Kaieteur (Lutz).

76. **Dendromyrmex chartifex** *F. Smith* var. **felis** *Mann* (MS.).

Worker. Differing from the typical form in having the body opaque and densely and finely punctate. Hairs on the head, thorax and gaster somewhat more abundant. There is no appreciable difference in color.

Female (deälated). Length 10.5 mm. Very closely resembling the worker. Numerous workers and a single female from Tukeit, in the fold of a leaf the edges of which had been drawn together and fastened with silk by a spider (?) (Lutz).

77. **Camponotus** (**Dinomyrmex**) **agra** *F. Smith.* Two minor workers from Kaieteur (Lutz).

78. **Camponotus** (**Dinomyrmex**) **mocsaryi** *Forel.* Three minor workers from Kaieteur (Lutz). The upper surface of the gaster is opaque and yellow, with a narrow transverse black band near the posterior edge of each segment. Forel does not describe the gaster but Emery mentions the black bands in the worker of this species (Rend. Accad. Inst. Sc. Bologna 1903, p. 20).

79. **Camponotus** (**Myrmothrix**) **rapax** *Fabr.* Several major and minor workers from Tukeit (Lutz).

80. **Camponotus** (**Myrmothrix**) **abdominalis** *Fabr.* Seven workers of the typical form of this variable species from Tukeit and Kaieteur (Lutz) and Bartica (Geo. Engelhardt). Three of the specimens, a media and two minors, are attached to leaves and have a fungus (*Cordyceps unilateralis* Tul.) growing out of the top of the head.

81. **Camponotus** (**Myrmosphincta**) **sexguttatus** *Fabr.* var. **fusciceps** *Emery.* Several workers and a deälated female from Kaieteur (Lutz). The head and antennal scapes of the female are black, the mandibles and funiculi deep red.

82. **Camponotus** (**Myrmamblys**) **novogrenadensis** *Mayr.* Eight workers from Fort New Amsterdam, Paramaribo, Dutch Guiana (Lutz).

83. **Camponotus** (**Myrmobrachys**) **senex** *F. Smith.* Numerous workers from Kaieteur and Tukeit (Crampton and Lutz).

84. **Camponotus** (**Myrmorhachis**) **rectangularis** *Emery.* A single worker from Tumatumari (Lutz).

85. **Camponotus** (**Myrmorhachis**) **latangulus** *Roger.* A single worker from Tumatumari (Lutz).

(*Continued from 4th page of cover.*)

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[Reprinted from Psyche, Vol. XXII, No. 6]

NOTES ON THE GENUS PHELISTER, MARS.[1]

By F. G. Carnochan.

While working on a revision of the Genus Phelister, of the United States, I noted a few points which it seems well to clear up at this time. Say, in 1825 described *Phelister subrotundus*, and also described a variety of *subrotundus* which he called var. A. This variety is characterized by having the fifth dorsal stria abbreviated in front. In the sixty-two specimens of *subrotundus*, which I have examined, I found seven of this variety, and consider that it merits a name.

Phelister subrotundus Say var. **sayi**, var. nov.

Oval, shining, black. Antennæ, legs, and elytra at each side and at tip, reddish brown. Front concave, punctured, frontal stria interrupted, but extending over the eyes. Thorax finely punctulate, more coarsely at the sides; marginal stria entire, fine; submarginal stria fine, distinct, abbreviated at base. Elytra with five entire striæ, the fifth extending just past the middle, and represented at the base by a single deep puncture; the sutural extending usually as far as the fifth. Propygidium sparsely punctured, pygidium sparsely and more minutely punctured. Anterior tibiæ multidenticulate.

The type of this variety is in my collection; paratypes in my collection and in that of Mr. C. A. Frost. I have seen also a second well marked variety which is, however, much more rare. In this variety the fourth dorsal stria is hooked towards the scutellum.

Phelister subrotundus Say var. **frosti**, var. nov.

Oval, shining, black. Antennæ, legs, and elytra at each side and tip, reddish brown. Front concave, punctured, frontal stria interrupted, but extending over the eyes. Thorax finely punctulate, more coarsely at the sides; marginal stria entire, fine; submarginal stria distinct, fine, abbreviated at base. Elytra with five entire striæ, the fifth distinctly hooked at base, the hook extending half way to the scutellum; sutural extending to middle or just in front of the middle. Propygidium sparsely punctured, pygidium sparsely and minutely punctured. Anterior tibiæ multidenticulate.

Described from three specimens; the type is in my collection; paratypes in the collection of Mr. C. A. Frost and the American Museum of Natural History.

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 106.

Both these varieties seem to coincide in range with *Phelister subrotundus*.

Two more species, *vernus* Say. and *saunieri* Mars. require attention. These two are very close but differ in essential points. In *vernus* the thorax is very sparsely and unevenly punctate, as is the pygidium, the form of the insect is distinctly elongate, and all of the twenty-four specimens which I have examined have a distinctly reddish tinge, thus producing a rusty appearance, although the general color is black. *Saunieri* is proportionately broader, and has the thorax evenly and rather densely punctate, the pygidium is also evenly punctate but not very densely, the color is a clear, shining black without a trace of reddish.

I believe that the latter is extensively confused with *vernus* in collections as all the eight specimens that I have seen have been sent to me under that name.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LX. No. 5.

THE ANTS OF THE PHILLIPS EXPEDITION TO PALESTINE DURING 1914.

By W. M. Wheeler and W. M. Mann.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
February, 1916.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUTENANT COMMANDER L. M. GARRETT, U. S. N., COMMANDING, PUBLISHED OR IN PREPARATION:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
H. B. BIGELOW. XXIII.[23] The Siphonophores.
H. B. BIGELOW. XXVI.[26] The Ctenophores.
R. P. BIGELOW. The Stomatopods.
O. CARLGREN. The Actinaria.
R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
H. L. CLARK. The Starfishes.
H. L. CLARK. The Ophiurans.
S. F. CLARKE. VIII.[3] The Hydroids.
W. R. COE. The Nemerteans.
L. J. COLE. XIX.[19] The Pycnogonida.
W. H. DALL. XIV.[14] The Mollusks.
C. R. EASTMAN. VII.[7] The Sharks' Teeth.
S. GARMAN. XII.[12] The Reptiles.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. XXVII.[27] The Schizopods.
S. HENSHAW. The Insects.
W. E. HOYLE. The Cephalopods.
W. C. KENDALL and L. RADCLIFFE. XXV.[25] The Fishes.
C. A. KOFOID. III.[3] IX.[9] XX.[20] The Protozoa.
C. A. KOFOID and J. R. MICHENER. XXII.[22] The Protozoa.
C. A. KOFOID and E. J. RIGDEN. XXIV.[24] The Protozoa.
P. KRUMBACH. The Sagittae.
R. VON LENDENFELD. XXI.[21] The Siliceous Sponges.
R. VON LENDENFELD. XXIX.[29] Hexactinellida.
G. W. MÜLLER. The Ostracods.
JOHN MURRAY and G. V. LEE. XVII.[17] The Bottom Specimens.
MARY J. RATHBUN. X.[10] The Crustacea Decapoda.
HARRIET RICHARDSON. II.[2] The Isopods.
W. E. RITTER. IV.[4] The Tunicates.
B. L. ROBINSON. The Plants.
G. O. SARS. The Copepods.
F. E. SCHULZE. XI.[11] The Xenophyophoras.
HARRIET R. SEARLE. XXVIII.[28] Isopods.
H. R. SIMROTH. Pteropods, Heteropods.
E. C. STARKS. XIII.[13] Atelaxia.
TH. STUDER. The Alcyonaria.
JH. THIELE. XV.[15] Bathysciadium.
T. W. VAUGHAN. VI.[6] The Corals.
R. WOLTERECK. XVIII.[18] The Amphipods.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.
[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
[7] Bull. M. C. Z., Vol. L., No. 4, November, 1906, 26 pp., 4 pls.
[8] Mem. M. C. Z., Vol. XXXV., No. 1, February, 1907, 20 pp., 15 pls.
[9] Bull. M. C. Z., Vol. L., No. 6, February, 1907, 48 pp., 18 pls.
[10] Mem. M. C. Z., Vol. XXXV, No. 2, August, 1907, 56 pp., 9 pls.
[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls
[15] Bull. M. C. Z., Vol. LII., No. 5, October, 1908, 11 pp., 2 pls.
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps
[18] Bull. M. C. Z. Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909, 10 pp., 3 pls.
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
[21] Mem. M. C Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem. M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls.
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 3 pls.
[26] Bull. M. C. Z., Vol. LIV, No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem. M. C. Z., Vol. XXXV., No. 4, July, 1912, 124 pp., 12 pls.
[28] Bull. M. C. Z., Vol. LVIII., No. 8, August, 1914, 14 pp.
[29] Mem. M. C. Z., Vol. XLII., June, 1915, 397 pp., 109 pls.

Bulletin of the Museum of Comparative Zoölogy
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PRINTED FOR THE MUSEUM.
February, 1916.

No. 5.— *The Ants of the Phillips Expedition to Palestine during 1914.*

CONTRIBUTIONS FROM THE ENTOMOLOGICAL LABORATORY OF THE BUSSEY INSTITUTION, HARVARD UNIVERSITY, NO. 107.

By W. M. Wheeler and W. M. Mann.

The junior author, while accompanying Dr. John C. Phillips on a recent zoölogical expedition to Palestine and the adjacent countries for the Museum of Comparative Zoölogy, succeeded in amassing quite a collection of ants. As many collections of these insects have been made from time to time in Egypt and Asia Minor and have been carefully described in numerous papers by Ern. André, Emery, Forel, Mayr, and Ruzsky, it seemed improbable that another collection would contain anything new. After the specimens were mounted and examined, however, we were surprised to find among them a new and peculiar species of Deromyrma and a few undescribed varieties and subspecies of well-known Mediterranean species. We decided, therefore, to publish a list of all the forms collected, together with such field-notes as seemed interesting.

Formicidæ.

1. *Ponera eduardi* Forel. ♂ ♀ (ergatoid).— Baniyas, Syria.
2. *Sima bifoveolata* Mayr var. *syriaca*, var. nov.

Worker. Agreeing very closely with the typical form described from Delagoa Bay and Zanzibar, except in the following characters: — the tibiæ have no suberect hairs, the mandibles have only three instead of four or five teeth, and the petiolar node is semicircular in profile. The tip of the gaster is not brown. The peculiar paired granular pits on the occiput seem to be quite as distinctly developed as in the type.

Several workers found running on plants at Wady Gazelle, Sinai Peninsula. The typical form has been recorded by Mayr only as far north as the White Nile where it was taken by Trägårdh.

3. *Aphaenogaster splendida* Roger. ♂ — Rasheya, Syria; in damp, shady places.

4. *Aphaenogaster* (*Deromyrma*) *phillipsi*, sp. nov. (Fig. 1).

Worker. Length 6–6.8 mm.

Very slender. Head twice as long as broad, with the rather small but convex eyes well in front of the middle of its sides; cheeks subparallel, distinctly convex, postocular borders of head straight and gradually converging to the occipital border, which has a strongly reflexed margin and is only about half as broad as the distance between the eyes. In profile the upper surface of the head is convex anteriorly, the gular surface flat. Mandibles with slightly concave external borders, three stout apical teeth and several basal denticles. Clypeus flat and subcarinate, the middle of its anterior border broadly and

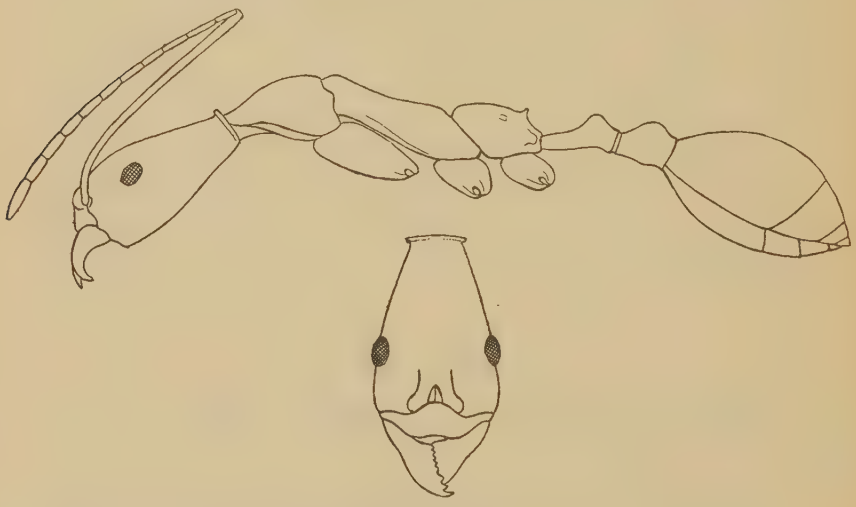

Fig. 1. *Aphaenogaster* (*Deromyrma*) *phillipsi*, sp. nov. Body of worker in profile; head of same from above.

sinuately excised. Frontal area impressed, distinct, with a median carinula. Frontal carinae approximated and parallel behind. Antennae very slender, the scapes surpassing the occipital margin by about $\frac{2}{5}$ their length; funiculus without a club, its joints very slender, the second, third, and terminal longest. Thorax slender, pro- and mesonotum subequal, the former in profile feebly convex, the latter sloping, slightly concave in the middle and with a small but distinct convexity in front just behind the promesonotal suture. Mesoëpinotal constriction abrupt, short and moderately deep. Epinotum in profile about $1\frac{1}{2}$ times as long as high, its base convex in profile and twice as

long as the concave declivity, armed with two small, rather acute teeth, which are directed upward and slightly backward and outward. Petiole more than twice as long as broad, in profile with a rather low, rounded node. Postpetiole about $1\frac{1}{3}$ times as long as broad, less than half again as broad as the petiole, in profile with a similar but somewhat larger node. Gaster elongate elliptical, narrowed in front. Legs very long and slender; spurs of the posterior tibiae short but distinct.

Gaster very smooth and shining, remainder of body more feebly shining. Mandibles subopaque, finely and densely striate; head, thorax, petiole, and postpetiole shagreened, the meso- and epinotum opaque, rugulose-punctate; the anterior portion of the head above, including the antennal foveae and excluding the clypeus, longitudinally rugose, becoming reticulately rugulose and punctate posteriorly; pronotum and upper surfaces of petiolar and postpetiolar nodes smoother and more shining. Epinotal declivity shining, feebly and transversely rugose.

Hairs yellow, very short, blunt, sparse on the body, entirely lacking on the legs; very short, but distinct and oblique on the antennal scapes, especially towards their tips. Pubescence absent.

Head, thorax, petiole, postpetiole, and antennae pale ferruginous; legs brownish yellow; gaster clear, pale yellow, with the posterior $\frac{3}{5}$ of the first segment dark brown.

Described from eleven workers from Petra, Palestine. These were found in the early morning eating portions of the bait with which small mammal traps had been baited.

This species differs considerably from either of the two previously described Palaearctic species of Deromyrma, *cecconii* Emery from Crete and *rhaphidiiceps* Mayr from Turkestan. The Cretan species is smaller (5.7 mm.), has the body black, the tibiae with oblique hairs, the petiolar node is angular in profile, the epinotal teeth are longer, the head is shorter and of a different shape behind and the antennal funiculi have an indistinct, 4-jointed clava. In coloration and the shape of the head *phillipsi* resembles *rhaphidiiceps*, but the latter is smaller, the occipital margin of the head has no reflected margin, the clypeal border is entire, the first funicular joint is longer than the second and the tibiae are hairy.

5. *Messor rufotestaceus* Foerster. ♀.— Wady Gharandel, Sinai Peninsula and Petra, Palestine; in the former locality living in crater nests, in the latter under stones and more abundant.

6. *Messor barbarus* Linné subsp. *structor* Latr. var. *orientalis* Emery. ☿ .— Rasheya, Ammik, and Baruk, Syria; Ain Gleidat and Wady Hisa, Palestine.
7. *Messor barbarus* Linné subsp. *semirufus* Ern. André. ☿ .— Ammik, Hasbeiya, Zahleh, and Baniyas, Syria; Wady Hisa, Palestine. One of the commonest ants in Syria, in crater nests.
8. *Messor barbarus* Linné subsp. *semirufus* Ern. André var. *concolor* Emery. ☿ .— Shiba, Syria; Fuweila, Arabia; Wady Feran, Sinai Peninsula; Wady Hisa, Palestine.
9. *Messor barbarus* Linné subsp. *meridionalis* Ern. André. ☿ .— Petra and Wady Mojeb, Palestine; Shiba and Wady El Katana, Syria.
10. *Messor barbarus* Linné subsp. *aegyptiacus* Emery. ☿ ♀ ♂.— Wady Feran, Wady Gazelle and Mt. Sinai, Sinai Peninsula; Cairo (Mann) and Fayum (Wm. Granger), Egypt.
11. *Pheidole pallidula* Nyl. ♃ ☿ .— Petra and Wady Kerak, Palestine; Ammik, Syria; Wady Feran and Wady Gazelle, Sinai Peninsula.
12. *Pheidole megacephala* Fabr. ♃ ☿ .— Baruk, Syria.
13. *Pheidole sinaitica* Mayr. ♃ ☿ .— Cairo, Egypt.
14. *Crematogaster scutellaris* Oliv. subsp. *schmitti* Mayr var. *ionia* Forel. ☿ .— Rasheya, Syria; Petra, Palestine. We refer these specimens to Forel's variety on account of the distinct infuscation of the head and thorax.
15. *Crematogaster auberti* Emery subsp. *jehovae* Forel. ☿ .— Wady Kerak and Ain Gleidat, Palestine; Shiba, Syria.
16. *Crematogaster auberti* Emery subsp. *antaris* Emery. ☿ .— Mt. Sinai, Sinai Peninsula; Fuweila, Arabia.
17. *Crematogaster inermis* Mayr. ☿ .— Mt. Sinai, Wady Gazelle, and Wady Feran, Sinai Peninsula; Wady Mojeb, Palestine. This is the commonest species of the genus in the Sinaitic Peninsula.
18. *Crematogaster lorteti* Forel. ☿ .— Ain Gleidat, Palestine. Many colonies, nesting under stones in moist localities.
19. *Monomorium venustum* F. Smith subsp. *niloticum* Emery. ☿ .— Wady Gazelle, Sinai Peninsula.
20. *Monomorium solomonis* Linné. ☿ .— Fuweila, Arabia; Wady Gharandel, Sinai Peninsula; Wady Mojeb, Palestine.
21. *Monomorium solomonis* Linné subsp. *subopacum* F. Smith var. *phoenicia* Emery. ☿ ♀ ♂.— Akaba, Arabia; Petra, Palestine.
22. *Monomorium bicolor* Emery subsp. *nitidiventre* Emery. ☿ ♀ .— Cairo, Egypt.

The female (deälated) measures 3.8–4 mm. and resembles the worker in color and sculpture, except that the base of the gaster above is yellowish red like the head, thorax, and pedicel and more opaque. Head longer than broad, with straight, subparallel sides, distinctly excised posterior border and rather angular posterior corners. Thorax elongate elliptical, fully $2\frac{1}{2}$ times as long as broad; in profile the dorsal surface of the mesonotum, praescutellum and scutellum form a straight line; epinotum with a pronounced median longitudinal impression. Postpetiole not broader than the petiole, distinctly broader than long.

23. *Monomorium abeillei* Ern. André. ♀.— Wady Feran and Wady Gazelle, Sinai Peninsula; Petra, Palestine.
24. *Monomorium* (*Holcomyrmex*) *dentigerum* Roger. ♀.— Petra, Palestine.
25. *Monomorium* (*Holcomyrmex*) *dentigerum* Roger var. *baal*, var. nov.

Worker. Differing from the typical form in its decidedly darker color, the body and antennal scapes being castaneous or blackish brown; the discs of the mandibles, the clypeus, front, cheeks, mesonotum, pleurae, and lower portions of the petiole and postpetiole deep red; the legs and tips of antennal scapes yellowish brown.

Numerous specimens from Shiba, Syria and Wady Kerak, Palestine.

26. *Leptothorax tuberum* Fabr. var. *luteus* Forel.

Three workers from Ain Gleidat, Palestine agree closely with the description of this form except that they have the posterior half of the first gastric segment and the whole of the remaining segments pale brown instead of yellow, like the remainder of the body. We deem it inadvisable to describe this form as a new variety on the basis of so little material.

27. *Tetramorium striativentre* Mayr. ♀.— Wady El Katana, Syria; Wady Mojeb, Palestine.
28. *Tetramorium caespitum* Linné. ♀.— Petra, Palestine.
29. *Tetramorium caespitum* Linné var. *forte* Forel. ♀.— Baruk, Syria.
30. *Tetramorium caespitum* Linné var. *schmitti* Forel. ♀.— Baruk and Ammik, Syria; Wady Mojeb, Palestine; Mt. Sinai, Sinai Peninsula.

31. *Tetramorium caespitum* Linné subsp. *punicum* F. Smith var. *lucidulum* Emery. ☿ .— Petra, Palestine; Ammik and Baniyas, Syria; Mt. Sinai, Sinai Peninsula. The colonies at Petra were very populous and were nesting under stones.
32. *Tetramorium caespitum* Linné subsp. *judas*, subsp. nov.

Worker. Length 2.3–3.5 mm.

Allied to the subspecies *semilaeve* Ern. André but the whole body, except the mandibles and clypeus, shining and the sculpture very feeble. Head much as in *semilaeve*, with the sides, posterior corners and a streak between the front and the posterior corners smooth and shining, the rugae on the front delicate and numerous, continued nearly or quite to the occiput. Pro- and mesonotum smooth and shining, with only traces of rugae at the sides, epinotum subopaque and rugose; pleurae more or less rugose as are also the sides of the petiole and postpetiole, the summits of the nodes of the latter shining, nearly smooth, or merely indistinctly punctate-rugulose. Gaster smooth and shining throughout. Color dark brown; mandibles, clypeus, cheeks, antennae, and legs testaceous.

Nine specimens from Wady Mojeb, Palestine.

This form seems to be near the var. *splendens* Ruzsky of the subsp. *semilaeve*, but we infer that the thorax is more strongly sculptured than the head in this form.

33. *Bothriomyrmex meridionalis* Roger var. *syria* Forel. ☿ .— Ain Gleidat, Palestine; Rasheya and Wady El Katana, Syria; Wady Gazelle, Sinai Peninsula.
34. *Tapinoma erraticum* Latr. ☿ .— Petra, Palestine; Baruk, Syria.
35. *Tapinoma erraticum* Latr. subsp. *nigerrimum* Nyl. ☿ .— Petra, Palestine; Fuweila, Arabia.
37. *Acantholepis frauenfeldi* Mayr. ☿ ♀ .— Wady Hisa, Palestine.
38. *Acantholepis frauenfeldi* Mayr var. *bipartita* F. Smith. ☿ ♀ .— Rasheya and Wady El Katana, Syria.
39. *Acantholepis carbonaria* Emery. ☿ .— Wady Gazelle, Sinai Peninsula.
40. *Acantholepis capensis* Mayr var. *canescens* Emery. ☿ .— Two workers from Fuweila, Arabia agree very closely with a single specimen of this ant from Erythraea in the senior author's collection. This variety is also recorded from Kaka on the White Nile and from Bogosland and Somaliland.

41. *Plagiolepis pygmaea* Latr. ☿ ♀.— Ain Gleidat and Petra, Palestine; Ammik, Syria; Wady Feran, Sinai Peninsula.
42. *Prenolepis* (*Nylanderia*) *jaegerskjoeldi* Mayr. ☿.— Cairo, Egypt; Wady Kerak, Palestine.
43. *Formica rufibarbis* Fabr. var. *clarorufibarbis* Ruzsky. ☿.— Baruk, Syria. The specimens have the base of the gaster red as in the var. *clara* Forel, but the top of the head is infuscated as in the typical *rufibarbis*.
44. *Cataglyphis bombycina* Roger. ♀ ☿.— Lake Fayum, Egypt (Wm. Granger).
45. *Cataglyphis bombycina* Roger var. *sinaitica*, var. nov.

Soldier and Worker. Differing from the typical form in the much darker coloration, the occiput, thorax, petiole, gaster, and femora being deep castaneous brown or even blackish, the knees, tibiae, head, antennal scapes, and first funicular joint and in some specimens also the thoracic dorsum, paler brown; the mandibles in the worker yellowish red. Antennal funiculi beyond the first joint and the teeth of the mandibles black. The hairs on the tibiae are distinctly longer than in the typical form and the silver pubescence, especially on the gaster, is even denser.

A single soldier and numerous workers from Wady Gazelle, Sinai Peninsula.

46. *Cataglyphis albicans* Roger subsp. *livida* Ern. André. ☿ ♀.— Petra, Palestine; Wady Gharandel, Sinai.
47. *Cataglyphis viatica* Fabr. subsp. *bicolor* Ern. André. ☿.— Baruk and Ammik, Syria; Wady Mojeb, Palestine.
48. *Cataglyphis viatica* Fabr. subsp. *bicolor* Ern. André var. *nigra* Ern. André. ☿.— Cairo, Egypt; Lake Fayum, Egypt (Wm. Granger).
49. *Cataglyphis viatica* Fabr. subsp. *bicolor* Emery var. *orientalis* Forel. ☿.— Wady Mojeb and Wady Hisa, Palestine; El Katana, Syria; Wady Feran and Wady Gharandel, Sinai Peninsula.
50. *Cataglyphis cursor* Fonsc. subsp. *aenescens* Nyl. ☿.— Shiba, Syria.
51. *Camponotus* (*Myrmoturba*) *maculatus* Fabr. subsp. *thoracicus* Fabr. var. *oasium* Forel. ☿.— Ammik, Syria; Wady Feran, Sinai Peninsula.
52. *Camponotus* (*Myrmoturba*) *maculatus* Fabr. subsp. *thoracicus* Fabr. var. *cypriacus* Forel. ☿ ♀.— Wady Gharandel, Sinai Peninsula.

53. *Camponotus* (*Myrmoturba*) *maculatus* Fabr. subsp. *thoracicus* Fabr. var. *xerxes* Forel. ☿ .— Zahleh, Syria.
54. *Camponotus* (*Myrmoturba*) *maculatus* Fabr. subsp. *thoracicus* Fabr. var. *sanctoides* Forel. ☿ — Wady Feran and Mt. Sinai, Sinai Peninsula.
55. *Camponotus* (*Myrmoturba*) *maculatus* Fabr. subsp. *thoracicus* Fabr. var. *mortis* Forel. ☿ .— Wady Feran, Sinai Peninsula.
56. *Camponotus* (*Myrmoturba*) *maculatus* Fabr. subsp. *sanctus* Forel. ☿ .— Shiba, Bakeyas, El Katana, and Rasheya, Syria; Petra, Palestine.
57. *Camponotus* (*Myrmoturba*) *maculatus* Fabr. subsp. *turkestanicus* Ern. André. ☿ .— Wady Hisa, Palestine.
58. *Camponotus* (*Myrmoturba*) *maculatus* Fabr. subsp. *baldaccii* Emery. ☿ .— Baniyas, Syria.
59. *Camponotus* (*Myrmoturba*) *maculatus* Fabr. subsp. *aethiops* Fabr. var. *concavus* Forel. ☿ .— Shiba, Syria; Mt. Hermon, Palestine.
60. *Camponotus* (*Orthonotomyrmex*) *lateralis* Oliv. var. *atricolor* Nyl. ☿ .— Rasheya and Ammik, Syria.
61. *Camponotus* (*Orthonotomyrmex*) *interjectus* Mayr. ☿ .— Wady Kerak, Palestine.
62. *Polyrhachis* (*Myrmhopla*) *simplex* Mayr. ☿ ♀ ♂.— Wady Kerak, Palestine; Wady Feran, Sinai Peninsula.

This species was very abundant in both of these localities, always in damp places and always associated with a certain tree. In Wady Feran several nests were seen on plants. These were made of portions of leaves and twigs fastened together with films of silk. In Wady El Katana, near the Dead Sea, the only nest found was beneath a stone at the base of a tree. It contained many larvae, some of which were lying on the ground, and others on a sheet of silk. On nearly every tree in the vicinity of this nest there were many Membracidae which were constantly attended by the *Polyrhachis* workers and in most cases even sheltered in sheds constructed by the ants. The workers were observed while carrying the larvae up the trees and using them to spin the silk of the sheds.

The following Publications of the Museum of Comparative Zoölogy are in preparation:—

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
E. L. MARK. On Arachnactis.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
K. BRANDT. The Thalassicolae.
O. CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
H. L. CLARK. The Ophiurans.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to LIV. and Vols. LVIII. and LIX.; of the MEMOIRS, Vols. I. to XXIX., and also Vols. XXXI. to XXXIV., XXXVI. to XXXVIII., XL. to XLII., and XLIV.

Vols. LV. to LVII., LX. and LXI. of the BULLETIN, and Vols. XXX., XXXV., XXXIX., XLIII., XLV. to XLIX. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Officers of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation:—

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

These publications are issued in numbers at irregular intervals. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LX. No. 8.

ANTS COLLECTED IN TRINIDAD BY PROFESSOR ROLAND THAXTER, MR. F. W. URICH, AND OTHERS.

By William Morton Wheeler.

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM.
March, 1916.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUTENANT COMMANDER L. M. GARRETT, U. S. N., COMMANDING, PUBLISHED OR IN PREPARATION:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
H. B. BIGELOW. XXIII.[23] The Siphonophores.
H. B. BIGELOW. XXVI.[26] The Ctenophores.
R. P. BIGELOW. The Stomatopods.
O. CARLGREN. The Actinaria.
R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
H. L. CLARK. The Starfishes.
H. L. CLARK. The Ophiurans.
S. F. CLARKE. VIII.[3] The Hydroids.
W. R. COE. The Nemerteans.
L. J. COLE. XIX.[19] The Pycnogonida.
W. H. DALL. XIV.[14] The Mollusks.
C. R. EASTMAN. VII.[7] The Sharks' Teeth.
S. GARMAN. XII.[12] The Reptiles.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. XXVII.[27] The Schizopods.
S. HENSHAW. The Insects.
W. E. HOYLE. The Cephalopods.
W. C. KENDALL and L. RADCLIFFE. XXV.[25] The Fishes.
C. A. KOFOID. III.[3] IX.[9] XX.[20] The Protozoa.
C. A. KOFOID and J. R. MICHENER. XXII.[22] The Protozoa.
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P. KRUMBACH. The Sagittae.
R. VON LENDENFELD. XXI.[21] The Siliceous Sponges.
R. VON LENDENFELD. XXIX.[29] Hexactinellida.
G. W. MÜLLER. The Ostracods.
JOHN MURRAY and G. V. LEE. XVII.[17] The Bottom Specimens.
MARY J. RATHBUN. X.[10] The Crustacea Decapoda.
HARRIET RICHARDSON. II.[2] The Isopods.
W. E. RITTER. IV.[4] The Tunicates.
B. L. ROBINSON. The Plants.
G. O. SARS. The Copepods.
F. E. SCHULZE. XI.[11] The Xenophyophoras.
HARRIET R. SEARLE. XXVIII.[28] Isopods.
H. R. SIMROTH. Pteropods, Heteropods.
E. C. STARKS. XIII.[13] Atelaxia.
TH. STUDER. The Alcyonaria.
JH. THIELE. XV.[15] Bathysciadium.
T. W. VAUGHAN. VI.[6] The Corals.
R. WOLTERECK. XVIII.[18] The Amphipods.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.
[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
[7] Bull. M. C. Z., Vol. L., No. 4, November, 1906, 26 pp., 4 pls.
[8] Mem. M. C. Z., Vol. XXXV., No. 1, February, 1907, 20 pp., 15 pls.
[9] Bull. M. C. Z., Vol. L., No. 6, February, 1907, 48 pp., 18 pls.
[10] Mem. M. C. Z., Vol. XXXV, No. 2, August, 1907, 56 pp., 9 pls.
[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls
[15] Bull. M. C. Z., Vol. LII., No. 5, October, 1908, 11 pp., 2 pls.
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps
[18] Bull. M. C. Z. Vol. LII , No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909, 10 pp., 3 pls.
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
[21] Mem. M. C Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem. M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV, No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem. M. C. Z., Vol. XXXV., No. 4, July, 1912, 124 pp., 12 pls.
[28] Bull. M. C. Z., Vol. LVIII., No. 8, August, 1914, 14 pp.
[29] Mem. M. C. Z., Vol. XLII., June, 1915, 397 pp., 109 pls.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LX. No. 8.

ANTS COLLECTED IN TRINIDAD BY PROFESSOR ROLAND THAXTER, MR. F. W. URICH, AND OTHERS.

By William Morton Wheeler.

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM.
March, 1916.

No. 8.— *Ants collected in Trinidad by Professor Roland Thaxter, Mr. F. W. Urich, and Others.*

CONTRIBUTIONS FROM THE ENTOMOLOGICAL LABORATORY OF THE BUSSEY INSTITUTION, HARVARD UNIVERSITY. NO. 108.

By William Morton Wheeler.

Formicidae.

1. *Ectatomma tuberculatum* Olivier. ☿ ♀.— Port of Spain and Sangre Grande (Thaxter).
2. *Ectatomma ruidum* Roger. ☿.— Port of Spain (Thaxter); Chaguanas (Urich).
3. *Neoponera obscuricornis* Emery var. *latreillei* Forel. ☿.— Caura (Urich).
4. *Neoponera unidentata* Mayr. ☿.— Port of Spain (Thaxter).
5. *Pachycondyla crassinoda* Latreille. ☿ ♀.— Port of Spain (Thaxter).
6. *Pachycondyla harpax* Fabricius. ☿.— Port of Spain (Thaxter).
7. *Pachycondyla impressa* Roger. ☿.— Port of Spain (Thaxter).
8. *Euponera* (*Mesoponera*) *constricta* Mayr. ☿ ♀.— Port of Spain (Thaxter).
9. *Euponera* (*Trachymesopus*) *stigma* Fabricius. ☿ ♀.— Port of Spain (Thaxter).
10. *Ponera opaciceps* Mayr. ☿.— Aripa Savanna (Thaxter).
11. *Odontomachus haematoda* Linné. ☿ ♀.— Port of Spain, Gasparee Island, and Sangre Grande (Thaxter).
12. *Odontomachus haematoda* Linné subsp. *insularis* Guérin var. *hirsutiusculus* F. Smith. ☿.— Port of Spain (Thaxter).
13. *Odontomachus haematoda* Linné subsp. *meinerti* Forel. ☿.— Port of Spain (Thaxter).
14. *Anochetus inermis* Ern. André var. *meinerti* Forel. ☿ ♀ ♂.— Chaguanas (Urich); Port of Spain (Thaxter).

The worker and female of this variety differ from those of the typical form in having the superior border of the petiole distinctly excised and the inner border of the mandibles with three teeth.

15. *Anochetus* (*Stenomyrmex*) *emarginatus* Fabricius (typical). ☿ .— Port of Spain (Thaxter); Ariopita Valley (H. D. Chapman).
16. *Eciton burchelli* Westwood. ☿ .— Port of Spain (Thaxter).
17. *Eciton burchelli* Westwood var. *urichi* Forel. ☿ .— Port of Spain (Thaxter); Erin (Urich).

I doubt whether this variety will prove to be valid. Among a large number of specimens from the same colony received from Urich, there are numerous transitions in color to the typical form.

18. *Eciton* (*Labidus*) *crassicorne* F. Smith. ☿ .— Matura (Urich); Port of Spain (Thaxter).
19. *Eciton* (*Acamatus*) *pilosum* F. Smith. ☿ .— Aripa Savanna (Thaxter).
20. *Pseudomyrma championi* Forel var. *paulina* Forel. ☿ .— Port of Spain (Aug. Busck and Thaxter).
21. *Pseudomyrma excavata* Mayr. ☿ .— Port of Spain (Thaxter).
22. *Pseudomyrma pallida* F. Smith. ☿ .— Aripa Savanna (Thaxter).
23. *Pheidole* (*Macropheidole*) *fimbriata* Roger. ♃ .— Port of Spain (Thaxter).
24. *Crematogaster brasiliensis* Mayr. ☿ .— Aripa Savanna and Sangre Grande (Thaxter).
25. *Crematogaster limata* F. Smith subsp. *parabiotica* Forel. ☿ .— Port of Spain and Gaspari Island (Thaxter).
26. *Monomorium floricola* Jerdon. ☿ .— Port of Spain (Thaxter).
27. *Megalomyrmex bituberculatus* Forel. ☿ .— Arima (Urich); Port of Spain (Thaxter).
28. *Tranopelta gilva* Mayr. ♀ ♂ .— Port of Spain (Aug. Busck).
29. *Solenopsis geminata* Fabricius. ☿ .— Port of Spain (Thaxter); Chaguanas (Urich).
30. *Solenopsis minutissima* Emery. ☿ .— Trinidad (Thaxter).
31. *Solenopsis altinodis* Forel. ☿ .— Port of Spain (Thaxter).

This species, which is easily recognized by the peculiar high petiolar node, rectangular in profile and laterally compressed, the absence of distinct clypeal ridges and the distinctly marginate epinotum, has been recorded from Trinidad by Forel. The types are from Zigzag, Venezuela.

32. *Solenopsis tenuis* Mayr. ☿ .— Port of Spain (Thaxter).
33. *Wasmannia auropunctata* Roger. ☿ ♀ .— Port of Spain (Thaxter).

34. *Mycocepurus smithi* Forel. ♀.— Diego Martin (Urich).
35. *Apterostigma wasmanni* Forel. ♀.— Four Roads, Port of Spain (Thaxter); "from fungus garden under a log."
36. *Apterostigma urichi* Forel. ♀.— Caparo (Thaxter); "from fungus garden under a log."
37. *Trachymyrmex urichi* Forel. ♀.— Ariopita Valley (H. D. Chapman); Gasparee Island (Thaxter).
38. *Trachymyrmex humilis*, sp. nov.

Worker. Length 2.2–2.5 mm.

Mandibles rather long, with concave external borders, three large apical and several smaller basal teeth. Head subrectangular, as broad as long, with broadly and feebly excised posterior and rather convex lateral borders and rounded posterior corners. Eyes moderately convex. Clypeus short, with nearly straight, entire anterior border. Expanded anterior lobes of frontal carinae moderately large, rounded, not angular, posterior ridges diverging but not reaching the posterior corners of the head. Praeorbital carinae straight, not curved inward across the antennal scrobes, terminating a little behind the eyes. Antennal scapes moderately stout, reaching a distance not exceeding their greatest transverse diameter beyond the posterior corners of the head. Joints 2–8 of the funiculi not longer than broad, two terminal joints forming an indistinct club, the penultimate longer than broad and half as long as the last joint. Thorax with the pro- and mesonotum rather convex and rounded in profile, the mesoëpinotal constriction short and deep. Inferior pronotal spines short, moderately acute. Epinotum much higher than long, the base in profile very convex anteriorly, sloping behind, broadly sulcate above, somewhat longer than the declivity, the spines reduced to two teeth which are only slightly longer than broad at their bases, directed upward, outward, and backward. Petiole small, not longer than high, the node feebly developed, acute in profile, with longer concave anterior and short concave posterior slope. Postpetiole very large, more than twice as broad as the petiole, as long as broad, broadest behind, with a median semicircular impression at the posterior border; in profile the node is very convex and high in front, the remaining dorsal surface flattened. Gaster suboblong, with rounded anterior and posterior corners, a little longer than broad, with straight, marginate sides, its upper surface evenly and feebly convex, without any longitudinal impressions. Legs moderately long.

Mandibles shining, with a few very coarse, elongate punctures.

Remainder of body opaque, very densely punctate-reticulate. The tubercles on the head, thorax, petiole, postpetiole, and gaster are small and rather uniformly distributed, noticeably so on the posterior corners of the head and dorsal surface of the gaster. On the front and vertex of the head they are somewhat elongate so that the general effect is that of several frequently interrupted rugae. Tibiae and femora covered with minute, uniformly distributed tubercles. What correspond to the spines and projections on the head and thorax of other species of Trachymyrmex are reduced to tubercles not much smaller than the teeth on the epinotum.

Hairs yellowish, very short, hooked, moderately abundant but not conspicuous. Pubescence of the same color, short, distinct only on the antennal funiculi.

Uniformly brownish ferruginous; mandibles a little darker, legs a little paler than the remainder of the body.

Two specimens; one from Gasparee Island and one from Port of Spain (Thaxter).

This species is very peculiar in its small size, small petiole, large postpetiole, and the great reduction of the spines and tubercles on the head and thorax.

39. *Acromyrmex octospinosus* Reich. ☿ .— Gasparee Island (Thaxter); Ariopita Valley (H. D. Chapman).
40. *Atta cephalotes* Linné. ☿ .— Port of Spain and Sewa Valley (Thaxter).
41. *Cryptocerus pusillus* Klug. ☿ .— Aripa Savanna (Thaxter).
42. *Cryptocerus* (*Zacryptocerus*) *clypeatus* Fabricius. ☿ .— Sangre Grande (Thaxter); Port of Spain (U. S. N. M.).
43. *Cryptocerus* (*Cephalotes*) *atratus* Linné. ☿ .— Port of Spain (Thaxter).
44. *Strumigenys saliens* Mayr. ☿ .— Port of Spain (Thaxter).

Codiomyrmex, gen. nov.

Worker. Monomorphic, closely related to Strumigenys F. Smith, Epitritus Emery, and Glamyromyrmex Wheeler, but differing in the shape of the head. Mandibles large, swollen, triangular, their apical margins with numerous, regular, acute teeth. Clypeus well developed, projecting over the extreme bases of the mandibles and not separated behind by distinct sutures from the head. Frontal carinae widely separated, expanded horizontally and continued backward to form sharp lateral margins as far as the posterior corners of the head, over-

arching broad scrobes for the antennae dorsal to the eyes, which are small but otherwise well developed. Ocelli absent. There is a short, sharp longitudinal carina ventral to the insertion of each antenna and a small acute tooth at each lateral corner of the gula near the lateral insertion of the mandible. Ocelli absent. Frontal area represented by a smooth, transverse region in the sculpture of the head; frontal groove represented by a raised line extending back to the vertex. Antennae, robust, 6-jointed. Thorax, petiole, postpetiole, and gaster much as in Strumigenys. Spongiform appendages well developed on the petiole, postpetiole, and base of gaster. Head coarsely sculptured. Squamiform or clavate hairs absent, but both the body and appendages covered with long, soft, dense, pointed hairs.

45. *Codiomyrmex thaxteri*, sp. nov. (Fig. 1).

Worker. Length nearly 2 mm.

Mandibles very convex dorsally and laterally, somewhat narrowed

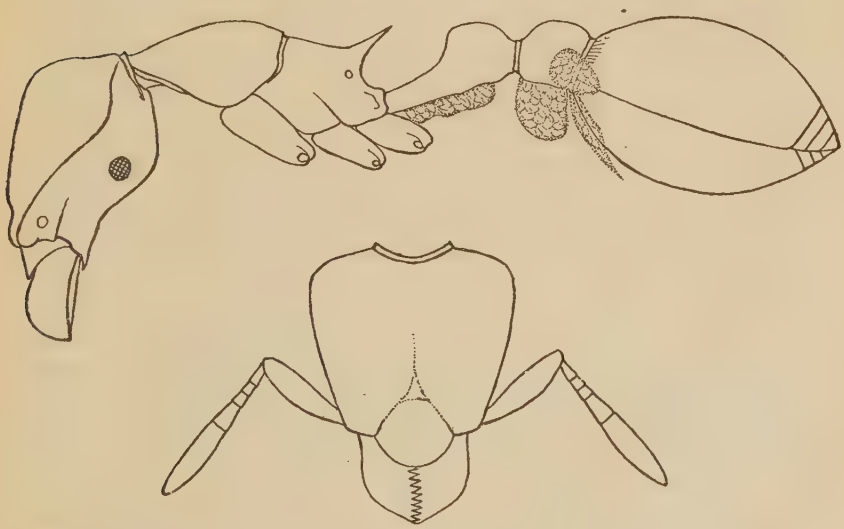


Fig. 1. *Codiomyrmex thaxteri*, sp. nov. Body of worker in profile; head of same from above.

at their insertions, their straight apical margins furnished with numerous, crowded, acute, and equal teeth. Head subtriangular, a little

longer than broad, decidedly broader behind than in front, with straight sides, rounded posterior corners, and narrow, excised, and marginate occipital border. In profile the head is very convex in the region of the vertex above and posterior portion of the gula below, flattened in front and on the sides to the sharp edge of the frontal carinae and their backward continuations. Clypeus rather concave, about as long as broad, with semicircular, entire anterior border. Eyes convex, at about the middle of the head, but near the ventral surface and not visible when the head is seen from above. Antennae robust, scapes terete but distinctly swollen, first funicular joint as long as the second and third together. These are subequal and scarcely longer than broad. Third joint longer than broad and nearly $\frac{1}{3}$ as long as the terminal joint. Thorax slender, through the pronotum about half as broad as the head, broadest through the humeri which are very projecting and distinctly angular or conical. Pro- and mesonotum in profile gently convex, not separated by a suture, the mesonotum laterally marginate and with a median longitudinal ridge, the mesopleurae high and rather concave. The lateral marginations of the mesonotum are continued back over the base of the epinotum into the spines, which are well developed, straight, and acute, nearly as long as the base of the epinotum and directed backward, upward, and outward. Their bases are laterally compressed and translucent below. Epinotal declivity concave, somewhat shorter than the base, its inferior angles compressed but not acute. Petiole with a long peduncle, as long as the node, which rises abruptly in front and has a gently convex, backwardly sloping dorsal surface; seen from above the node is as long as broad and evenly rounded and submarginate on the front and sides. Attached to the ventral border of the peduncle and node is a long, compressed, band-shaped, transparent, spongiform appendage. Postpetiole from above, transversely elliptical, nearly twice as broad as the petiolar node and twice as broad as long, in profile a little longer than high, evenly convex above, with a large and prominent ventral and two smaller, lateral spongiform appendages. Gaster a little larger than the head, elliptical, with nearly straight anterior and rather sharply marginate lateral borders, its ventral as convex as its dorsal surface and nearly the entire surface formed by the first segment. Its anteroventral surface is furnished with a flat, squamiform and pointed spongiform appendage. Legs rather long and stout.

Mandibles shining, evenly and sparsely punctate. Head subopaque; clypeus and upper surface of head reticulate-rugose and coarsely punctate; antennal scrobes and gula densely and evenly punctate; region of the frontal area smooth and shining. Thorax

smooth and shining, except the epinotum, the base of which is coarsely, the declivity and sides more finely reticulate-punctate. Petiole and postpetiole shining, the node of the former opaque, coarsely and somewhat longitudinally reticulate-rugose, the node of the latter coarsely and sparsely punctate. Gaster smooth and shining, its extreme base with short, longitudinal rugae. Antennal scapes coarsely and densely punctate, opaque; legs smooth and shining.

Hairs yellowish gray, very fine, long, dense, flexuous, and erect, covering the whole body and legs, as long on the latter as on the former, shorter and subappressed on the antennae, where they are if anything even denser. Pubescence absent.

Castaneous brown; clypeus, head, and antennal scapes black; mandibles, bases of antennal funiculi, neck, knees, tibiae, tarsi, anterior portion of first gastric segment, and whole of terminal gastric segments, deep red.

Described from three specimens taken by Professor Thaxter in the neighborhood of Port of Spain.

This species is very easily recognized by the singular shape of the head and peculiar fleece-like pilosity of the body. I have made it the type of a distinct genus, though it is evidently much like a Strumigenys, except in the structure of the head, because I believe that this latter genus is soon destined to suffer disintegration into a number of subgenera or genera. This fate has already overtaken several other ant-genera (Camponotus, Formica, Crematogaster, Monomorium, Pheidole, etc.) that have become unwieldy through accumulation of species which even a very conservative myrmecologist must regard as heterogeneous.

46. *Dolichoderus attelaboides* Fabricius. ♀.—Arima (Urich); Port of Spain (Thaxter).
47. *Dolichoderus decollatus* F. Smith. ♀.— Port of Spain (Thaxter).
48. *Dolichoderus* (*Hypoclinea*) *bidens* Linné. ♀.— Tamana (Urich).
49. *Dolichoderus* (*Hypoclinea*) *championi* Forel var. *taeniatus* Forel. ♀.—Port of Spain (Thaxter). A single worker of very small size, but agreeing in color and structure with cotypes from Colombia.
50. *Dolichoderus* (*Hypoclinea*) *championi* Forel subsp. *trinidadensis* Forel. ♀.— Port of Spain (Thaxter).

A single worker differing from a cotype specimen received from Professor Forel only in having the head, tibiae, and antennal scapes dark brown.

51. *Dolichoderus* (*Monacis*) *bispinosus* Olivier. ☿ ♀ ♂.— Port of Spain (Thaxter); Erin (Urich).
52. *Dolichoderus* (*Monacis*) *debilis* Emery. ☿.— Matura (Urich); Sangre Grande (Thaxter).
53. *Iridomyrmex dispertitus* Forel subsp. *micans* Forel. ☿.— Port of Spain (Thaxter).
54. *Tapinoma melanocephalum* Fabricius. ☿.— Aripa Savanna (Thaxter).
55. *Azteca chartifex* Forel. ☿.— Arima (Urich).
56. *Azteca chartifex* Forel subsp. *decipiens* Forel var. *lanians* Forel. ☿ ♀.— Arima (Urich).
57. *Azteca barbifex* Forel. ☿.— Port of Spain (Thaxter).
58. *Azteca trigona* Emery subsp. *mediops* Forel. ☿.— Port of Spain (Thaxter); Ariopita Valley (H. D. Chapman).
59. *Azteca foreli* Emery subsp. *ursina* Forel. ☿.— Chatham, "on cacao" (Urich).
60. *Azteca velox* Forel. ☿.— Arima (Urich).
61. *Azteca velox* Forel var. *nigriventris* Forel. ☿.— Port of Spain (Thaxter).
62. *Prenolepis* (*Nylanderia*) *longicornis* Latreille. ☿.— Sangre Grande (Thaxter).
63. *Prenolepis* (*Nylanderia*) *vividula* Nylander. ☿.— Port of Spain (Thaxter).
64. *Camponotus* (*Dinomyrmex*) *agra* F. Smith. ☿.— Platanal (Urich).
65. *Camponotus* (*Myrmothrix*) *abdominalis* Fabricius. ☿.— Port of Spain (Thaxter); Ariopita Valley (H. D. Chapman).
66. *Camponotus* (*Myrmothrix*) *femoratus* Fabricius. ☿.— Port of Spain (Thaxter).
67. *Camponotus* (*Myrmobrachys*) *excisus* Mayr. ☿.— Port of Spain (Thaxter).
68. *Camponotus* (*Myrmobrachys*) *senex* F. Smith. ☿.— Port of Spain (Thaxter).
69. *Camponotus* (*Myrmobrachys*) *lindigi* Mayr. ☿.— Gasparee Island (Thaxter).
70. *Camponotus* (*Myrmobrachys*) *zoc* Forel. ☿.— Ariopita Valley (H. D. Chapman).
71. *Camponotus* (*Myrmorhachis*) *latangulus* Roger. ☿.— Port of Spain (Thaxter).
72. *Camponotus* (*Myrmorhachis*) *bidens* Mayr. ☿.— Port of Spain (Thaxter).

The following Publications of the Museum of Comparative Zoölogy are in preparation:—

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
E. L. MARK. On Arachnactis.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
K. BRANDT. The Thalassicolae.
O. CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
P. SCHIEMENZ. The Pteropods and Heteropods.
THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK The Holothurians.
H. L. CLARK The Ophiurans.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
G. W. MÜLLER. The Ostracods.
MARY J. RATHBUN. The Crustacea Decapoda.
G. O. SARS. The Copepods.
L. STEJNEGER. The Reptiles.
C. H. TOWNSEND. The Mammals, Birds and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to LIV. and Vols. LVIII. and LIX.; of the MEMOIRS, Vols. I. to XXIX., and also Vols. XXXI. to XXXIV., XXXVI. to XXXVIII., XL. to XLII., and XLIV.

Vols. LV. to LVII., LX. and LXI. of the BULLETIN, and Vols. XXX., XXXV., XXXIX., XLIII., XLV. to XLIX. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Officers of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation:—

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

These publications are issued in numbers at irregular intervals. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

New and Noteworthy Hemiptera from New England.[1]

By H. M. Parshley, Bussey Institution, Harvard University.

During the past two years I have examined a large number of New England Hemiptera, among which I have found several new forms and numerous species not hitherto supposed to occur in this region. The records noted herewith are of special interest, and in several cases the known range of the species is materially extended. Such results show clearly how inadequate is our present knowledge as a basis for generalizations on the distribution of the Hemiptera, and they emphasize the importance of intensive investigations restricted to limited areas.

GERRIDAE.

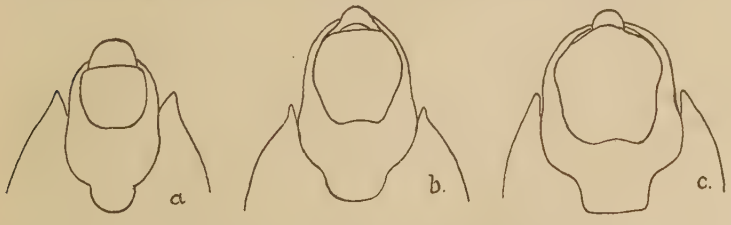
Gerris argenticollis sp. nov. (Fig. *a*).

Dark velvety brown above with fine sericeous pubescence. Anterior lobe of the pronotum with median and marginal yellow stripes, the former faint, the latter clothed with thick silvery pubescence; posterior lobe with yellow margins. Inner margins of hemielytra marked at base with white between the veins. Under surface black or silvery depending on the direction of the light; acetabula, bases of anterior legs and margins of abdomen marked conspicuously with yellow; omphalium and legs variable, black to pale brown.

Relative proportions: of antennal segments, 1st 26, 2nd 13, 3rd 12, 4th 10; of intermediate legs, femur 50, tibia 43, 1st tarsal segment 20, 2nd 10.

Thorax comparatively robust; abdominal spines not reaching apex of abdomen.

♂. Fifth abdominal sternite notched at middle of posterior margin; sixth abdominal sternite not carinate, ventral surface of abdomen not



Male genitalia of *Gerris*, ventral view; *a*, *G. argenticollis* n. sp.; *b*, *G. marginatus* Say; *c*, G. *buenoi* Kirk.

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 109.

distinctly depressed just anterior to genital segment (as it is in *buenoi*), median ventral (second) emargination narrow, semicircular; genital segment narrow, Fig. *a*.

♀. Lateral plates of genital segment together very slightly wider than long, widest at middle, carinate ventrally.

Length from tip of tylus to apex of abdominal spines, ♂ 7.5-8 mm.; ♀ 8-8.5 mm.

Holotype (♂) and allotype (taken in copulation) in my collection; paratypes in the Museum of Comparative Zoology, Cambridge; Boston Society of Natural History; United States National Museum; and the Academy of Natural Sciences, Philadelphia.

Described from 10 males and 16 females taken at Forest Hills, Massachusetts, 26 April, 4 May, 20 May, 1915, from a woodland pond where it was associated with *G. marginatus* Say and *G. buenoi* Kirk. A female specimen from Southern Pines, North Carolina, 15 March, 1915 (Manee) belongs to this species. This form pertains to the subgenus *Gerris*. It is distinguished from *G. buenoi* and *G. marginatus* by the white markings at the base of the hemielytra, the form of the genitalia, Figs. *a-c*, and the marginal stripes of the anterior lobe of the pronotum which are not silvery in the former and lacking in the latter.

MIRIDAE.

Heterocordylus malinus Reut. Durham, New Hampshire (No. 2485, W. & F.).

This is the most northern record for the species, and the first indication of its occurrence in New England. It is seriously destructive in New York, where it is known as the "apple red-bug."

Pithanus maerkeli H. S. Eastport, Maine, 15 July, 1909 (C. W. Johnson).

In going over some unmounted material belonging to the Boston Society of Natural History, I recently came across seven brachypterous specimens of this European species, which were taken by sweeping in a field. This record, the first for New England, indicates the establishment of the species in this country. It was first recorded by Olsen, from

Long Island, and I have lately seen a specimen from Truro, Nova Scotia, taken by Mr. W. H. Brittain.

HEBRIDAE or NAEOGEIDAE.

Hebrus (or **Naeogeus**) **burmeisteri** Leth et Sev. Edgartown, Martha's Vineyard, Massachusetts, 28 June, 1912. (C. W. Johnson).

One specimen only of this species has been present in the material which I have thus far examined.

REDUVIIDAE.

Apiomerus ventralis Say. Monmouth, Maine, 26 June, 1906, Framingham, Massachusetts, 12 June, 1904.

One of several unusually interesting Hemiptera collected by Mr. C. A. Frost, the coleopterist. It has been considered a southern and western species.

Zelus socius Uhl. Monmouth, Maine, 18 July, 1914 (Frost), Hopkinton, Massachusetts, 14 June, 1914 (Frost), Portland, Connecticut, 10 August, 1913 (Walden).

These I believe to be the first New England records for this species.

TINGITIDAE.

Galeatus peckhami Ashm. Mt. Washington (Glen House, Osgood Trail), New Hampshire, 20 July, 1915 (C. W. Johnson).

This curious Tingitid is a notable addition to the New England fauna.

CORIZIDAE.

Corizus hyalinus Fab. Woods Hole, Massachusetts, 2 July, 1905 (J. A. Cushman).

This species inhabits the warmer regions of the Old and New Worlds and is an addition to the rather long list of more typically southern forms occasionally found along the southern coast of New England.

COREIDAE.

Anasa repetita Heid. Wallingford, Connecticut, 1911 (D. J. Caffrey), Boston (near Chestnut Hill), Massachusetts, 24 Sept., 1914 (Parshley).

The first New England records for this species were published by Mr. C. W. Johnson, Psyche, 1914, p. 82. I took the specimen noted above while sweeping underbrush in open woods, together with *A. armigera.*

Anasa armigera Say. Boston, Massachusetts, 24 Sept., 1914; 13 Oct., 1915 (Parshley).

I believe that these are the first New England records for this species. The two specimens were taken at almost the same spot in two successive years. The individual captured in 1914 differs in some details from typical western specimens in my collection, but the other is so distinctly intermediate as to forbid even racial separation from typical *armigera*.

PENTATOMIDAE.

Zicrona caerulea Linn. Newbury Neck (near Surrey), Maine, 22-24 June, 1904 (F. A. Eddy).

This cosmopolite is widely distributed in the West, but there is only one other record of its occurrence in New England (Mt. Washington, New Hampshire). I have compared the specimen with others in my collection from the Caucasus and Java and note but slight differences apart from size.

[Reprinted from the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 9, No. 1, 1916]

FURTHER STUDIES ON WILT OF GIPSY MOTH CATERPILLARS[1]

By J. W. CHAPMAN and R. W. GLASER

INTRODUCTION

During the past two summers (1914–1915) certain questions in connection with wilt of gipsy moth caterpillars have begun to clarify. The published experimental results obtained during the summer of 1913, while helpful in interpreting many of the phenomena encountered in this interesting problem, nevertheless left much in doubt. Our efforts were renewed during the summer of 1914 with the hope of verifying all of our previous experiments (1913) and of solving some of the questions towards which we had begun to assume a sceptical attitude. Many interesting matters were forcibly impressed upon us during the course of this study which extended over two seasons. The results obtained in 1914 were discouraging although instructive. In 1915, however, we not only obtained data harmonizing with those of 1913, but surpassing our expectations by yielding new and interesting results. This work also clearly revealed the inadequacy of some of our methods.

In order that other investigators interested in the polyhedral diseases of insects may be spared many of the tedious difficulties which we encountered we present our work historically, and will attempt to give an account of the methods which must be pursued in order to ensure dependable results. This method of procedure will also have the advantage of placing our new results in a proper light.

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[1] Contribution from the U. S. Bureau of Entomology in coöperation with the Bussey Institution of Harvard University. (Bussey Institution No. 110.)

Summary of Our Previous Work

The results obtained by our previous studies may be summarized as follows:

1. The wilt of gipsy moth caterpillers is a true infectious disease distributed over the entire territory infested by the gipsy moth.
2. Epidemics of the disease occur only in localities heavily infested by the gipsy moth.
3. Climatic conditions appear to bear an important relation to wilt in the field.
4. The disease is more prevalent among older than among younger caterpillars, but the latter also die of wilt in the field.
5. No diagnosis of wilt is valid unless polyhedra are demonstrated microscopically.
6. There is no record of the occurrence of wilt in the gipsy moth in America prior to 1900.
7. Minute dancing granules may be observed in wet smears.
8. Polyhedra are probably reaction bodies belonging to the highly differentiated albumins, the nucleoproteids.
9. The pathology of wilt does not vary with the age of the caterpillars.
10. The polyhedra originate in the nuclei of the tracheal matrix, hypodermal, fat, and blood cells.
11. The nuclei of the tracheal matrix and blood cells seem to be the first tissue nuclei affected.
12. Many minute violently dancing granules are found in the pathological nuclei of fresh tissue.
13. Giemsa's stain demonstrates many little granules in the nuclei of diseased tissue sections.
14. The alimentary canal seems to be the last organ in the body to disintegrate.
15. Two types of blood corpuscles exist in normal hæmolymph.
16. Two types of pathological blood corpuscles exist in diseased caterpillars.
17. The blood is a fairly reliable index of a caterpillar's condition.
18. The blood test is impracticable for large experimental series.
19. Bacteria are not etiologically related to wilt.
20. The virus of wilt is filterable with difficulty.
21. Such a filtrate is free from bacteria and polyhedral bodies.
22. Caterpillars that have died from infection with filtered virus are flaccid, completely disintegrated, and full of polyhedra.
23. Minute dancing granules were observed in the Berkefeld filtrates. These may be identical with certain granules observed in smears and tissue nuclei (sub. 7, 12, and 13) and may be etiologically significant.

24. The incubation period of wilt varies, and temperature at times seems to bear an important relation to this variation.

25. A large number of caterpillars used in the experiments died of disturbances in their normal physiological activities.

26. The success of wilt infection experiments is absolutely dependent upon attention to seemingly insignificant details.

27. Genetic immunity of certain individuals is probable.

28. Active immunization with sublethal doses is possible.

29. The polyhedral bodies may be stages of the filterable virus, but as yet no evidence to substantiate this view has been produced.

30. Infection naturally takes place through the mouth by means of the food.

31. There is no evidence that the wind is an important factor in distributing the disease.

32. Some of the imported parasites may be important factors in aiding the dispersion of wilt.

33. Although probable, there is no definite evidence as yet that wilt is transmitted from one generation to another.

Problems Requiring Further Investigation

From a review of our work during 1913 it seemed apparent that many wilt problems needed further investigation and verification. For this reason we concentrated our work upon the following questions:

(a) Can we obtain further evidence in order to substantiate our view that wilt is a true infectious disease?

(b) Can we produce further evidence that wilt is caused by a minute filterable organism?

(c) If wilt is caused by a filterable virus can we obtain some idea of its size?

(d) Has wilt a definite period elapsing between inoculation and death?

(e) What influence do climatic conditions (temperature and humidity) have on the length of this period?

(f) Does immunity towards wilt exist in certain members of the gipsy moth race?

(g) Is wilt transmitted from one generation to the next through the egg?

Difficulties Encountered in 1914

In order more lucidly to illustrate the satisfactory methods devised during the summer of 1915 we would like to present five out of fifteen experiments performed during the summer of 1914. The gipsy moth caterpillars used for these experiments were collected in the field while in the third and fourth instars from localities where no wilt had been noticed up to the time of the collection. The animals were

taken to the laboratory, and isolated from one another in autoclaved pasteboard or sterile tin boxes. Thus by isolation, all animals that harbored the disease and died before being used for experimental purposes were prevented from infecting others. This precaution was found necessary for the reason that it is impossible to determine during the early stages of the disease, whether or not a caterpillar is free from wilt infection. Of course Escherich's blood test method for eliminating chronic cases might have been used, but Glaser and Chapman (1913) and Glaser (1915) have shown that the blood test is impracticable for large experimental series.

Caterpillars dead from wilt were emulsified with sterile water. This material (amounting to about 100 c.c.) was filtered through cotton and later through paper. The filtrate thus obtained was passed through a Berkefeld Grade "N" filter by the use of a vacuum of approximately 28 inches. This Berkefeld filtrate was used for the infection experiments. Of course, the filtrate was tested for its bacterial sterility by plating on ordinary nutrient media. If the proper technical precautions are taken the filtrate obtained will be free from bacteria and polyhedral bodies.

The caterpillars were infected by holding the animals with their ventral side up. By means of a sterile eye dropper a drop of the filtrate was then placed directly over the mandibles. By exercising sufficient patience the animals can be made to drink the drop or even two or three large drops. It must be borne in mind that caterpillars will not drink prior to moulting, so it is important to obtain them after moulting or two or three days previous to this act. Moreover, caterpillars which have recently fed are unwilling to drink and therefore it is best to starve them for 24 hours before attempting an infection.

Every caterpillar in our experiments was infected with the same amount of the virus. Suffice it to say, that we prepared the virus in the same way for each experiment, and further attempted to have conditions as constant as possible.

Table I gives the results obtained in the first experiment. Twenty-five caterpillars were infected with the Berkefeld "N" filtrate and 25 controls were infected with the same filtrate sterilized by autoclaving for 20 minutes. Eighteen caterpillars died of wilt in the experiment and 19 in the controls. One individual escaped; one died of another cause (possibly bacterial infection), and 11 moths were obtained. Table II is self-explanatory. Tables III and IV represent similar experiments with the exception that the material was passed through the finer Grade "W" Berkefeld filter. By an examination of Tables I and II it will be seen that the deaths due to wilt in the controls exceed those in the experiments. In Table III the deaths in the experi-

ments exceed those in the controls by two. In Table IV the deaths in the experiments exceed those in the controls by 15. It was absolutely impossible to come to any conclusions on the results based on the above experiments. Table V represents an experiment in which 25 animals were infected with fresh, undiluted and unfiltered gipsy moth wilt virus. Twenty-five controls accompanied this experiment. As can be seen the deaths in the controls exceeded those in the experiments by six. Altogether fifteen experiments were performed and the results were all very similar to those outlined above. Can such discouraging results find an explanation, and how can they be made to harmonize with those obtained in 1913? The only feasible explanation which occurred to us was that many of the caterpillars used in our experiments in 1914 were chronically infected with wilt before being collected and that this accounted for the high mortality in the controls. Why some of the animals infected with the unsterilized virus survived and produced moths can possibly be explained by the suggestions offered by Glaser and Chapman (1913) and Glaser (1915). In short it seems very likely that many individuals are naturally immune towards wilt. In the discussion of the Berkefeld filtration experiments of 1913 it was further pointed out, that the wilt virus is difficult to filter on account of the abundance of cellular débris, pigment granules, hairs and polyhedral bodies. A film very soon becomes deposited on the outside of the Berkefeld candle and of course this retards filtration. In order partially to overcome this retardation, the virus was diluted to about 100 c.c. of sterile water and filtered through a fine grade of paper prior to filtration through the candle. As is well known, however, the albuminous material, polyhedral bodies, etc., easily pass through filter paper so that it is practically impossible to obtain material for the Berkefeld filter which will not deposit a film on the candle. Absorption of material into the interior of the candle necessarily also must retard the filtration. Naturally, the old candles must be frequently replaced by sterile new ones even during the course of one filtration.

As stated previously, the results obtained in 1914 were gravely at variance with those of 1913. Evidently we were fortunate in collecting healthy material in 1913, but our 1914 results clearly demonstrated that our chance method of obtaining healthy material ended disasterously. Another method had to be devised.

Origin of Material for the 1915 Experiments

If further experimental progress was to be made, it was thought absolutely necessary to raise a stock of caterpillars free from wilt infection or at least a stock in which the wilt mortality was reduced to a

minimum. After producing such a wilt-free stock, we could then rely upon individuals from such a stock for experimental purposes and the results would be significant. During the season of 1915 we raised several sets of caterpillars from eggs. In some sets or cultures no wilt mortality occurred throughout the entire season; in most of the other cultures wilt appeared, but the mortality was low. How certain individuals in these latter cultures became infected is open to several explanations, the most probable of which would seem to be that wilt is transmitted from one generation to another through the egg. Chronic carriers of the previous generation may resist death, pupate, transform and transmit the disease, as is the case with pébrine, to certain individuals of the next generation. Some members of this second generation become susceptible and die. That carelessness was responsible for the deaths in those cultures where wilt appeared spontaneously seems highly improbable for the reason that every conceivable bacteriological precaution was taken. We even went so far as to import daily the food for the animals from a territory which had never harbored gipsy moth caterpillars. The foliage before being picked was further examined for the presence of other lepidopterous larvæ. This precaution was thought to be necessary for the reason that Chapman and Glaser (1915) found wilt prevalent amongst ten of our native species of lepidoptera and the possibility of food contamination is very great.

In 1915 two sets of eggs were hatched. One set had its origin from moths that emerged from the control experiments the previous year (1914). The other set was kindly given us by Professor Richard Goldschmidt, who for several years has been investigating certain genetical questions in connection with the gipsy moth. Some of these eggs were derived from a pure Japanese race procured by Professor Goldschmidt from Ogi, Japan; others were derived from crosses between Japanese races with a race from Germany and one from Fiume, Hungary. The caterpillars from this second set of eggs were very easily distinguished from our introduced American race, by their peculiar coloring and pattern. Professor Goldschmidt informed us that he had had very little disease in his cultures the previous year, so we thought his material ought to prove very instructive.

Altogether a great many cultures were cared for, both American and foreign. These cultures represented our stock from which we took animals whenever they were needed for experimental purposes. Some of the animals were immediately removed from the stock on hatching and isolated, others were treated in bulk. At the beginning of the season, while the caterpillars were still in the second stage, many individuals died of wilt in three American cultures. These cultures

were quickly discarded for fear that the infection might spread to the remaining individuals.

Animals needed for an experiment were taken from a particular stock culture. The remaining individuals comprising this stock were kept under close observation throughout the season *i. e.*, the number of deaths and the number of moths which emerged were recorded. Thus in most cases, we were able to determine the health of a particular culture. Needless to say, no deaths in stock or experiment were attributed to wilt unless all the gross and microscopic symptoms were typical. (See Glaser, *Journal of Agricultural Research*, Vol. IV, No. 2, p. 104.)

Simple and Passage Infections

The following experiments were performed in order to prove whether or not wilt is a true infectious disease. All caterpillars used for an experiment were taken from a particular stock and isolated in separate, small, round tin boxes measuring three-fourths inches in depth and two and one-half inches in diameter. Such tin boxes were found far superior to the pasteboard boxes used during previous seasons. By keeping the lid closed the proper humidity conditions are obtained and the food remains fresh for two or three days if not eaten. The caterpillars also moult regularly in these tin boxes and they seem not to suffer in the least from their confinement. Lastly, the tin boxes can be easily sterilized by boiling water and can be used over again repeatedly.

The stock animals were nearly all raised in glass fruit jars measuring about three and one-half inches in height and in diameter. By screwing on the tin tops, the proper humidity conditions could likewise be obtained. If the humidity increased sufficiently so that drops of water formed on the glass, a little dry sand put into the bottom of each jar soon absorbed the excess moisture.

Table VI gives the results of the first experiment. Twenty fifth stage foreign *dispar* caterpillars were isolated, ten for the experiment and ten for the controls. Caterpillars which died of wilt were ground up in a motar with sufficient sterile water to facilitate the process. This liquid was strained through cheesecloth and then diluted to 40 c.c. with sterile water. The solution was next filtered through paper in a Buchner filter by using a slight suction. Ten caterpillars were fed from an eye dropper (method of feeding described on page 152) with the Buchner filtrate and ten controls, fed with the same filtrate sterilized by autoclaving, accompanied the series. Eight caterpillars died of typical wilt in the experiment and no controls succumbed. Two controls died of an "other cause." Two moths in the experiments and eight moths in the checks emerged. In the stock culture of 240

from which the animals were derived, $1\frac{1}{4}$ per cent died spontaneously of wilt and 78 per cent of "other causes."

Tables VII and VIII represent experiments similar to the one presented on Table VI with the exceptions that fourth stage American caterpillars were used in experiment VII and Japanese third stage animals in experiment VIII.

Table IX represents an experiment performed with American fourth stage caterpillars. Five animals were used in the experiments and five in the controls. Not a single animal died from wilt.

Tables X and XI represent passage infections. A caterpillar which died in one of the previous infection experiments was ground up and diluted to 10 c.c. with sterile water. This material was strained through cotton, filtered through paper in a Buchner filter, and fed to foreign fifth stage individuals represented on Table X. Twelve individuals were fed with the Buchner filtrate; 12 were fed with this filtrate autoclaved and 33 untreated caterpillars accompanied the series. The results can be gathered by consulting the Table.

Table XI represents the next passage. A caterpillar that died in the previous experiment was used. The material was treated in the same way, *i. e.*, ground up, diluted to 10 c.c. and filtered. Fifth stage foreign caterpillars were used.

Discussion of the Infection Experiments

The following data derived from a comparative study of the mortality tables are worthy of discussion: The number of caterpillars which died of wilt in the experiments and checks; the relation between the percentage of wilt mortality in the stock cultures and the percentage of wilt in the checks; the number of caterpillars which died of "other causes" in the experiments and checks; the relation between the percentage of "other cause" mortality in the stock cultures and the percentage of deaths due to that cause in the experiments and checks; the number of moths obtained in the experiments.

In the tables the wilt mortality of the experiments equals 68 per cent; in the checks 4 per cent. How can we explain the 4 per cent wilt in the checks? By comparing the wilt mortality in the checks with the wilt mortality in the stock culture in each table, we find that the condition of the stock usually explains the wilt mortality in the checks. Thus in Table VI none of the checks died of wilt and the wilt mortality in the stock was very low ($1\frac{1}{4}$ per cent). In Table VII we have two cases of wilt in the checks and the mortality in the stock is rather high (9 per cent). In Table VIII one check died of wilt and the mortality in the stock is high (11 per cent). In Table IX no wilt is recorded and none in the stock. In Table X none is recorded in the

checks and none in the stock. In Table XI one case of wilt is recorded in the checks and none in the stock. The explanation offered to account for the 4 per cent check mortality is based on the above data, namely, when the stock wilt mortality is low or zero, the checks which are derived from such stock are likely to be healthy; when the stock wilt mortality is high, some of the checks which are derived from such stock are likely to be diseased. Table XI seems to be a slight exception to this rule. In this experiment no wilt is recorded in the stock, but one in the checks. It must be borne in mind, however, that the number of this stock culture was rather small and it is really unfair to base a health estimate on it. Of course, this one check may not have been chronically infected before being used. It may have contracted the disease subsequently by accidental infection, but this seems unlikely.

Under the heading died of "other causes" are grouped all of those animals that showed none of the gross and microscopic symptoms of wilt. Caterpillars which succumbed to this "other cause" death were usually in the fourth or fifth stage. They frequently hung by their prolegs in the typical wilt fashion, but their skin was tough and did not rupture easily as is the case with typical wilted individuals. On dissection such individuals proved to be practically free from body fluids, in contradistinction to the deliquescent state of wilted animals. In many cases the organs and tissues were almost shrunken beyond recognition due to the loss of blood and body fluids. No polyhedra were ever found in such animals, but smears from the intestine revealed countless Saccromycetes and Micrococci. Sections through these caterpillars failed to reveal the above mentioned microörganisms in any organ excepting the intestine. The Saccromycete and a Micrococcus were isolated from animals which died of this disease and other healthy ones were infected with these pure cultures. We failed to reproduce the disease with either microörganism. It might be well to mention that the Saccromycete grows very readily on bean and potato agar, and the Micrococcus flourishes on beef infusion and on beef extract agar.

A very interesting fact was noticed in all of the stock cultures and experimental animals. Nearly all of the individuals which died of the "other cause" death and which revealed the Saccromycete and Micrococci microscopically and culturally, were derived from the foreign eggs given us by Professor Goldschmidt. Very few American caterpillars could be found which yielded the above named microörganisms. The few found probably became infected from the foreign stock. By comparing the tables representing American with those representing foreign animals, and further by comparing the percentage of "other

cause" deaths in the stock cultures with the same deaths in the experimental animals, actual experiments, checks and untreated individuals, the facts to which we have here called attention stand out very vividly. (Compare Tables VI, VIII, X and XI with Tables VII and IX.)

Professor Goldschmidt experienced a high mortality in some of his Japanese gipsy moth cultures. We had the opportunity to examine many of his dead animals and found that the percentage of deaths due to the "other cause" was very much greater than the percentage of wilt mortality.

So far as the "other cause" mortality is concerned, the following facts are clear:

(1) The "other cause" mortality discussed in this article is not at all comparable to the mortality similarly designated by Glaser and Chapman in 1913. In 1913 it was due to low humidity; in this case probably due to one or more microörganisms.

(2) We believe that this "other cause" mortality is a specific disease which has no direct relation to wilt.

(3) This "other cause" mortality was never found during previous seasons in our American laboratory or field animals.

(4) It appeared for the first time this year (1915) in our foreign cultures and later spread to two or three American cultures.

(5) This new disease appears only during the later stages of the caterpillars (fourth and fifth stages).

By comparing Tables VI, VII, IX and X it will be seen that from one to five moths were obtained in nearly all of the actual infection experiments. There can be no doubt that the caterpillars partook of the virus for we were very persistent in seeing that they actually drank. Therefore, we offer two explanations: first, that certain individuals among gipsy moth caterpillars are immune to wilt. We have obtained eggs from such individuals and it will be interesting to note during the next season whether this immunity is transmitted to any of the next generation. Second, that certain individuals after inoculation become chronically diseased, but are nevertheless capable of undergoing metamorphosis. If this is the case wilt might be transmitted from one generation to another through the egg. The rearing of individuals from such eggs ought to throw much light on the subject.

Berkefeld Filtrate Experiments

Glaser and Chapman (1913) showed that bacteria in the ordinary sense of the word are not etiologically related to wilt, but that the evidence is very great in favor of the view that wilt is caused by a filterable virus.

The following experiments are offered as further proof for our view. Tables XII and XIII represent two experiments which duplicate one another in every detail.

Wilted material was ground up with sterile water and strained through cheesecloth. The liquid was then filtered through paper and equalled 70 c.c. This was next filtered through a Berkefeld "N" candle by gravity. Platings were made of the filtrate and since no bacteria grew it was considered sterile for ordinary forms. A portion of this same filtrate was centrifuged electrically and the bottom sediment examined microscopically. No bacteria or polyhedral bodies could be detected in fresh and stained smears. The animals used for these two experiments were all in the fourth stage and came from an American stock. They were, furthermore, all derived from the same egg cluster. Thirty-two animals were fed, by means of an eye dropper, with the Berkefeld "N" filtrate; 28 with the filtrate sterilized by autoclaving and 20 untreated individuals accompanied this series. In one experiment, Table XII, nine out of 32 animals infected with the unsterilized virus died of wilt. Moths were obtained from all the rest. In the other experiment, Table XIII, four out of 32 animals infected with the unsterilized virus died of wilt. The remaining individuals all transformed. Table XIV represents another similar experiment with slight variations. Fifth stage American caterpillars were used. The wilted material after preparation equalled 25 c.c. This was diluted to 100 c.c. and filtered through a Berkefeld "N" candle by means of a vacuum of about 27 inches. Ten animals were fed with the filtrate and ten with the filtrate sterilized by autoclaving. Four out of the 10 animals infected with the unsterilized virus died of wilt; three in the experiment and two in the checks died of "another cause" and moths were obtained from the remainder. Of course, no death was diagnosed as wilt unless all the gross and microscopic symptoms were typical.

By comparing the Berkefeld experiments with the simple infection experiments, one is at once impressed with the small number of deaths among the infected animals (23 per cent) in the former against 68 per cent in the latter. Of course, immunity may account for a number of the moths, but the difference between the two sets of experiments is too great for the immunity theory to account for all. This difference between Berkefeld and simple infection experiments was also noticed in 1913, and in 1914, and we offer the explanation presented on page 153 (absorption by candle and film deposition). Significant in these Berkefeld experiments is the fact that none of the checks died of wilt. As can be seen from the tables (XII, XIII and XIV), the condition of the stock was responsible for these gratifying results.

Pasteur-Chamberland Filtrate Experiments

Since our experiments seem to demonstrate that the wilt virus is capable of passage through Berkefeld candles it was thought imperative to ascertain whether or not the virus could be passed through something finer, namely, through Pasteur-Chamberland filters. For this reason the two following experiments (Tables XV and XVI) were performed. The virus was prepared in the usual way and equalled 60 c.c. This was passed through a Berkefeld "N" filter (vacuum of 27 inches) after which the resulting filtrate was passed through a Pasteur-Chamberland "F" filter (vacuum of 27 inches). Fifth stage foreign caterpillars were used in both experiments and the animals were infected by the pipette method. Tables XV and XVI are self-explanatory. Suffice it to say, that not a single animal died of wilt in either the experiments or checks. These two experiments seem to demonstrate that none of the virus is capable of passage through the Pasteur-Chamberland "F" filter. In other words, the size of the organism concerned in wilt lies somewhere between the size of the Berkefeld and Pasteur-Chamberland filter pores. Of course, some of the virus may have passed through, but was not sufficient to gain a foothold on account of a natural immunity of the animals. This, however, is pure speculation at present.

Is There any Relation between Sacbrood and Wilt?

In 1913 White discovered a disease in bees caused by a filterable virus, which he named Sacbrood for the reason that the dead larvæ when removed from their cells have the appearance of a small closed sac. The main difference between Sacbrood and wilt, however, seems to consist in the fact that polyhedral bodies have never been found by White in cases of Sacbrood. Of course, this fact need not exclude the possibility of the identity of the two diseases, for the bee larval tissue reaction towards the disease may be entirely different from the caterpillar tissue reaction. Polyhedral bodies may not be formed when the virus invades bee larvæ although formed when the same virus gains entrance to the caterpillar body.

Through the kindness of Dr. G. F. White, we obtained some Sacbrood material. At the same time we sent Dr. White some wilt material so that he could perform the reciprocal infection, *i. e.*, infect bee larvæ with the wilt virus. None of Dr. White's experimental bee larvæ developed Sacbrood or wilt as it is known in caterpillars. Tables XVII and XVIII represent two experiments accompanied by controls, in which gipsy moth caterpillars were infected with Sacbrood. As can be seen none of the animals so treated succumbed to wilt. From these experiments performed by us in coöperation with Dr. White, we conclude that wilt and Sacbrood are two distinct diseases.

Period from Infection to Death

In wilt a definite period elapses between the time of inoculation by feeding and death. This period varies slightly depending on the dosage, but is fairly constant in a certain class of experiments in which the dosages are constant. Tables XIX and XX graphically illustrate what happened in our simple and Berkefeld infection experiments. Table XIX represents the simple infections. Each square along the ordinate represents the greatest number of caterpillars that died on a particular day; the abscissa represents the number of days covered by the experiments. The first deaths occurred 13 days and the last deaths 27 days after inoculation. The highest point in the mortality is reached 18 days after inoculation. The mean for the entire simple infection experiments is 20 days. Table XX represents the Berkefeld infections. In this series the first death occurred 15 days and the last 29 days after inoculation. The highest point in the mortality is reached 23 days after inoculation. The mean for the entire Berkefeld infection experiments is 23 days.

By comparing the simple infection Table (XIX) with the Berkefeld infection Table (XX), it will be seen that in general the time from inoculation to death in the Berkefeld experiments is longer than in the case of simple infections. This difference between the two sets of experiments is due to differences in the concentration of the doses of the virus administered. In the Berkefeld experiments, as previously mentioned (p. 153), dilution, absorption, and film deposition play important rôles in decreasing the concentration of the virus and hence one would expect a longer period to elapse before the disease proves fatal. Table XXI represents Tables XIX and XX combined. The mean for both sets of experiments is 21 days.

Daily humidity and temperature records were kept during the entire experimental season by means of self-recording instruments for the purpose of determining whether or not these climatic factors had any influence in shortening or lengthening the period from inoculation to death. We have very carefully compared all of our records with the wilt mortality occurring in our experiments, but we have been absolutely unable to find any correlation between temperature and wilt or humidity and wilt or between both climatic factors and wilt.

On the basis of this failure to find any correlation (1915) between climatic conditions and wilt in our insectary, we would not like to exclude such a possible influence. Our records for the entire season show that the temperature and humidity were fairly constant. No extremes were reached in our insectary which was a subterranean greenhouse, so we feel obliged to continue these climatic observations in connection with wilt for another season or two before making any final statement.

Summary

(1) The chance method for obtaining healthy experimental material is absolutely worthless on account of chronic carriers.

(2) By selection a stock of caterpillars can be produced in which spontaneous wilt mortality is reduced to a minimum.

(3) Wilt is a true infectious disease.

(4) The virus of wilt is filterable through Berkefeld "N" candles.

(5) Caterpillars that have died from infection with the filtered virus are flaccid, completely disintegrated, and full of polyhedra.

(6) Microscopic examinations of the bottom sediment of centrifuged Berkefeld filtrates and platings of such filtrates show that they are sterile for bacteria.

(7) Berkefeld filtrates are free from polyhedral bodies.

(8) The nuclear inclusions called polyhedral bodies or polyhedra are by-products of the disease.

(9) We have been unable to force the wilt virus through Pasteur-Chamberland "F" filters.

(10) In our experiments the period from inoculation by feeding to death varied from 13 to 29 days. The mean for simple infections is 20 days; for Berkefeld infections 23 days. The mean for all the experiments is 21 days.

(11) An accurate record of the stock cultures is necessary for the interpretation of experimental results.

(12) Wilt seems to be transmitted from one generation to another through the egg.

(13) Certain individuals among gipsy moth caterpillars seem to be immune towards wilt.

(14) A new disease appeared in our foreign stock.

(15) A Saccromycete and a Micrococcus were isolated from cases of this new disease.

(16) The new disease appeared only during the later stages (fourth and fifth) and differ clinically and microscopically from wilt.

(17) Field observations have never revealed this new disease in our American race.

(18) Sacbrood and wilt are not identical.

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Table I. Mortality among American Gipsy Moth Caterpillars in Laboratory Experiments

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
25	Berkefeld "N"	18	1 escaped 1	5 (3♂ 2♀)
25	Berkefeld "N" autoclaved	19		6 (3♂ 3♀)

Table II. Mortality among American Gipsy Moth Caterpillars in Laboratory Experiments

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
20	Berkefeld "N"	6	2	12♀♀
20	Berkefeld "N" autoclaved	15	3	2♀♀

Table III. Mortality among American Gipsy Moth Caterpillars in Laboratory Experiments

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
25	Berkefeld "W"	8	1 escaped 2	14 (11♂ 3♀)
25	Berkefeld "W" autoclaved	6	2	17 (14♂ 3♀)

Table IV. Mortality among American Gipsy Moth Caterpillars in Laboratory Experiments

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
20	Berkefeld "W"	17	2	1 ♀
20	Berkefeld "W" autoclaved	2	6	12 (4♂ 8♀)

TABLE V. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
25	Undiluted wilt	4	21	
25	Undiluted wilt autoclaved	10	1	14 { 3♂ 11♀

TABLE VI. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" deaths in Stock of 240
10	Buchner filtrate	8		2 { 1♂ 1♀	1¼% wilt
10	Buchner filtrate autoclaved		2	8 { 3♂ 5♀	78% "other causes"

TABLE VII. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 31
10	Buchner filtrate	6		4 { 2♂ 2♀	9% wilt
10	Buchner filtrate autoclaved	2		8 ♀	0% "other causes"

TABLE VIII. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 114
10	Buchner filtrate	5	5		11% wilt
10	Buchner filtrate autoclaved	1	4	5 { 3♂ 2♀	27% "other causes"

TABLE IX. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 162
5	Buchner filtrate		1	4♀	0% wilt
5	Buchner filtrate autoclaved			5♀	1¼% "other causes"

TABLE X. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 10
12	Buchner filtrate	10	1	1 ♀	0% wilt
12	Buchner filtrate autoclaved		2	10 { 9♂ 1♀	20% "other causes"
33	Untreated		4	29 { 14♂ 15♀	

TABLE XI. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 10
12	Buchner filtrate	11	1		0% wilt
12	Buchner filtrate autoclaved	1		11 { 5♂ 6♀	20% "other causes"
11	Untreated		4	7 { 6♂ 1♀	

TABLE XII. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 42
32	Berkefeld "N"	9		23 { 9♂ 14♀	0% wilt
28	Berkefeld "N" autoclaved			28 { 9♂ 19♀	0% "other causes"
20	Untreated			20 { 10♂ 10♀	

TABLE XIII. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 42
32	Berkefeld "N"	4		28 { 16♂ 12♀	0% wilt
28	Berkefeld "N" autoclaved			28 { 9♂ 19♀	
20	Untreated			20 { 4♂ 16♀	0% "other causes"

TABLE XIV. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 30
10	Berkefeld "N"	4	3	3 { 1♂ 2♀	0% wilt
10	Berkefeld "N" autoclaved		2	8 ♀	No record of "other cause" percentage

TABLE XV. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 71
10	Pasteur-Chamberland "F"		1	9 { 4♂ 5♀	7% wilt
10	Pasteur-Chamberland "F" autoclaved		1	9 { 2♂ 7♀	17% "other causes"

TABLE XVI. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock
10	Pasteur-Chamberland "F"		1	9 { 6♂ 3♀	None left in stock
10	Pasteur-Chamberland "F" autoclaved		2	8 { 3♂ 5♀	No wilt in stock up to time caterpillars were used

TABLE XVII. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
10	Sacbrood of Bees		2	8 { 5♂ 3♀
10	Sacbrood of Bees autoclaved		1	9 { 4♂ 5♀

TABLE XVIII. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
5	Sacbrood of Bees		3	2 (1♂ 1♀)
5	Sacbrood of Bees autoclaved		2	3 (2♂ 1♀)

TABLE XIX. SIMPLE INFECTIONS, SHOWING PERIOD FROM INFECTION TO DEATH

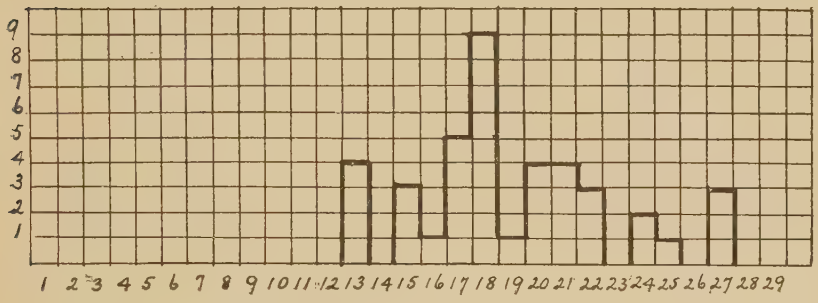


TABLE XX. BERKEFELD INFECTIONS, SHOWING PERIOD FROM INFECTION TO DEATH

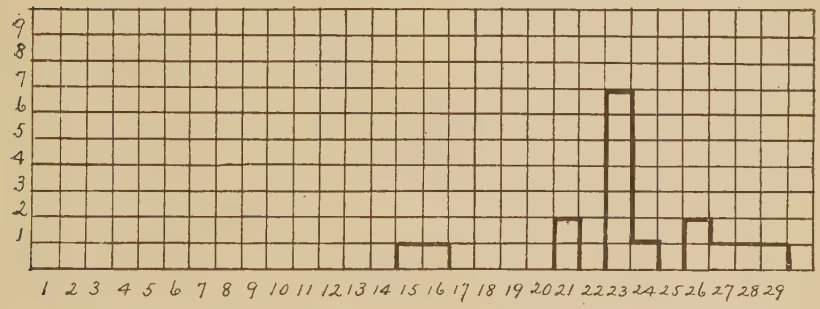
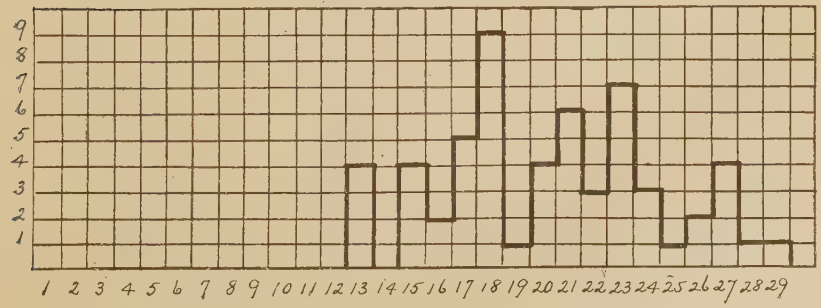


TABLE XXI. TOTAL INFECTIONS, SHOWING PERIOD FROM INFECTION TO DEATH



Photogenic Organs and Embryology of Lampyrids

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Reprinted from JOURNAL OF MORPHOLOGY, Vol. 28,
No. 1, December, 1916

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PHOTOGENIC ORGANS AND EMBRYOLOGY OF LAMPYRIDS

F. X. WILLIAMS

TEN PLATES

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INTRODUCTION

This paper is a part of the results of two years work at the Bussey Institution of Harvard University, on the habits, structure and development of two common fireflies, Photuris pennsylvanica and Photinus consanguineus. The first of these furnished nearly all of the embryological material and the second was the more advantageous for the study of the development of the photogenic organ of the adult. Not much attention was paid to the physiological aspects of the problem.

The material obtained was studied both in the living state and in sections. Most used for killing the embryological material was hot water followed by increasing strengths of alcohol. Larvae, pupae and adults were first immersed in hot water and then in warm Kahl's fluid (Water, 30 parts; 96 per cent alcohol, 15 parts; formalin, 6 parts; glacial acetic acid, 1 part). Usually the material was imbedded in paraffin, but when the chitin was very thick, celloidin was used. Embryos were usually stained in toto with borax carmine; the sections with Heiden-

JOURNAL OF MORPHOLOGY, VOL. 28, NO. 1
Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 111.

hain's iron haematoxylin with orange G, eosin or Congo red as a counter stain, the first of these proving best. Sections were cut from 3.5 to 15 micra thick. Osmic acid was much used for the study of the 'tracheal end cells,' while caustic potash brings out the tracheal capillaries very satisfactorily.

I wish to thank all who have aided me in my work and especially Dr. W. M. Wheeler and Professor C. T. Brues, under whose supervision my studies were made, for many helpful suggestions and criticisms.

ORIGIN AND DEVELOPMENT OF THE PHOTOGENIC ORGANS

There are, in general, two views as to the origin of the photogenic organs in the Lampyridæ; according to one they are developed from the ectoderm; according to the other they are related to the fat-body and are therefore mesodermal. These two beliefs rest upon a diversity of observations and facts. The development of the photogenic organs of the European Lampyris noctiluca has been studied by Vogel ('13), who published a rather brief paper without illustrations on the subject. There does not appear to be any fundamental difference between his observations and mine. As far as I know, Vogel's studies are the only ones of their kind.

Lindemann ('63) considers the photogenic body to be a nervous organ. This view is not remarkable when we find that he figures a part of the central nervous system as the light-organ.

Owsjannikow ('68) believes that the light-organ of Lampyris consists of a group of epithelial cells of a glandular nature. Presumably, like the majority of glands in insects, he considers these cells to be ectodermal.

Gegenbaur ('74), in speaking of the light-organs of fireflies, advances the view that the non-luminous or urate layer is derived from the fat-body, whereas the photogenic layer is a modification of the hypodermis.

Heinemann ('86) in speaking of the elaterid, Pyrophorus noctiluca, p. 298, says: "Die Leuchtorgane der Cucujo's gehören wie diejenigen den Lampyriden dem Hautsystem an."

Dubois ('98), in his studies on the light-organs of Lampyridae and of Pyrophorus noctiluca, found, from an examination of the ova of the Lampyrids, a resemblance between the blastoderm cells and the photogenic cells of the larva, pupa and adult. He concludes with reason that it is these cells and not the nutritive yolk which give rise to the light-organ. It would seem that some of the photogenic material is transmitted to the eggs by the mother insect. He says, p. 310:

> Les noyaux se sont multipliés dans un certain nombre de gros plastides hypodermiques, et de ceux-ci s'échappent des files de jeunes éléments, dont la masse forms l'organe lumineux larvaire . . . ; plus tarde, celui-ci s'isolera: la photographie de cette nouvelle coupe, que je projette sur le tableau, vous permet de comprendre facilement sa texture.

As a result of this proliferation, the underlying hypodermis is very sparse or lacking. His figure 139 illustrates this condition. Dubois' figure of the photogenic organ of Pyrophorus noctiluca is rather different from that of the Lampyridae. Dahlgren and Kepner ('08), and Geipel ('15) figure a portion of the photogenic organ of Pyrophorus, and it can be seen that it has essentially the same structure as that of Photuris and Photinus. Dubois describes, further, the formation of the light-organ in the female Lampyris noctiluca, and bases his observations largely upon a pupa about to transform into an adult. The process is described as essentially similar to that which occurs in the larva, the photogenic cells being derived from the underlying hypodermis in such a manner that the oldest of the light cells are nearest the alimentary tract. My studies on Photinus consanguineus show that the reverse is true, for the older cells (as far as position is concerned) are nearest the hypodermis, although from a developmental standpoint they are all of about equal age. Marchal ('11) follows Dubois and regards the photogenic tissue as ectodermal.

Treviranus ('18) seems to be among the first investigators to have decided that the fat-body and light-organ are of the same substance, since he says, p. 102: "Ich finde die leuchtende Substanz dieser Käfer (Elater noctilucus und phosphoreus) ganz

einerley mit dem Fettkörper derselben. . . . . ." Peters ('41), on page 241, says that, although the fat-body cannot be mistaken for the light-organ, it seems probable that the chief constituent of the latter is fat. Leydig ('57) considers the light-organ an essential part of the adipose tissue.

Von Kölliker ('57) styles the light-organ a nervous apparatus, because the albuminous material of which it is composed is oxidized under the direct influence of the nervous system. He believes, however, with Leydig that the organ is fatty.

Max Schultze ('65) who studied the photogenic organ of Lampyris splendidula quite thoroughly, believed that it is related to the fat-body. Emery ('84), who has investigated the organ of Luciola italica, considers it of fatty origin. Wieolowjski ('90) thinks that the two layers of the organ differ in origin, the upper or non-luminous being fat-like, the lower ectodermal, since it is composed of certain oenocytes.

Seaman ('91) upholds the derivation of the organ from the fat-body. Wheeler ('92) says: "The resemblance between the fat body and the light organ is so great that I do not doubt their genetic relationship though I have not studied the development."

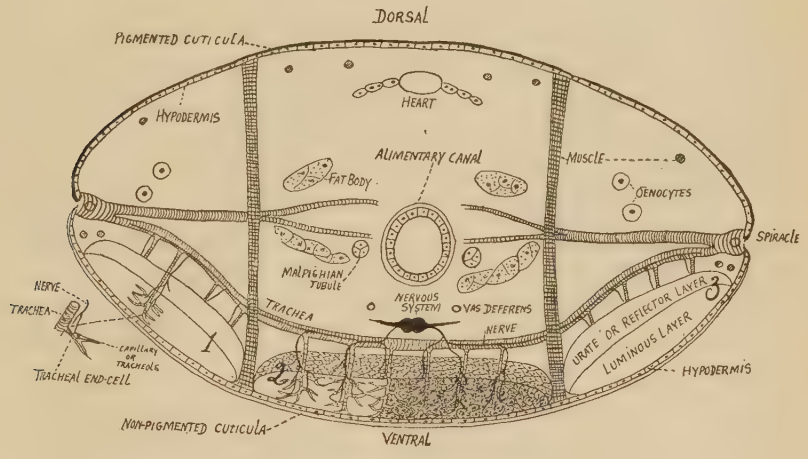
Bongardt ('03), Berlese ('09) Dahlgren and Kepner ('08) believe the photogenic organ to be a derivative of the fat-body, and Vogel ('13) has shown that the light-organ of Lampyris noctiluca is derived directly from the fat-body.

Pierantoni ('14) figures in section the light-organ of Lampyris and the symbiotic organ of the homopteron, Aphrophora spumaria. It must be admitted that there is a striking similarity between the two structures. The small bodies, one or two micra in diameter, observed in the photogenic layer, he believes may be luminous bacteria, which, as in the non-luminous bacteria of the Homoptera, are inherited, since they are transmitted to the egg while it is still in the ovary.

Buchner ('14), in following the opinion of Pierantoni, sees a possible relationship of the light-organ to the specialized fat-body (pseudovitellus) of the Homoptera, and a support of his views of symbiotic mycetoms.

Geipel ('15) gives the structure of the light-organs some study. He believes it possible that all light-organs in the Lampyridae may not be derived from the fat-body.

It is evident that the luminous organs of insects need not be mesodermal in origin, for we have but to consider the very efficient light-organs of the mycetophilid fly of the New Zealand caves.[1]



Here, curiously enough, the light-organs are a modified portion of the Malpighian tubules, which of course, are ectodermal (Wheeler and Williams, '15).

STRUCTURE OF THE PHOTOGENIC ORGANS

In all the forms of fireflies (Lampyridæ) which have been studied, as well as the brilliantly luminous elaterid beetle, Pyrophorus noctiluca, the photogenic organs, whether of the larva, pupa or adult, present the same general structure. The short description which follows, together with the accompanying diagram, text-figure 1, should give the reader some idea of their makeup. The photogenic organs usually occupy a part or the

[1] This fly does not appear to be confined to New Zealand, for Morton ('91) reports what seems to be the same or a very similar insect from the caves of Tasmania.

whole of one or more ventral abdominal segments. Briefly stated, the light-organ is composed of two layers of cells, an inner or non-photogenic (urate or reflector) layer, and an outer luminous or photogenic layer. The inner layer functions as a reflector and is opaque in life and rather translucent when fixed and stained. From the contents of its cells it is also known as the urate layer. The outer or photogenic layer is clear in living, and deeply-staining in fixed material; it owes the latter property largely to the numerous little photogenic granules which sometimes fill its cells. Outwardly the photogenic later is overlaid by the thin hypodermis, which in this region usually secretes non-pigmented cuticle. Tracheae and nerves penetrate both layers inwardly, but in this respect the photogenic layer is the more richly supplied. The vertical branches from the main tracheal trunks give off many fine tracheae, which terminate as branching capillaries or tracheoles among the photogenic cells. These capillaries are surrounded, at least in part, by cytoplasm, which, together with the basally situated nucleus, constitutes a tracheal end-cell.

DEVELOPMENT OF THE PHOTOGENIC ORGANS IN THE ADULT PHOTINUS CONSANGUINEUS

The development of the photogenic organ of the adult is best studied in the male, for it here occupies the whole ventral portion of segments six and seven of the abdomen. (It is a common error, as pointed out by Vogel, for students of the photogenic organs of the Lampyridae, to designate these organs as occurring on the fifth and sixth segments, etc., when in reality they are situated on the segments immediately following. This can be readily seen in the larva, also by counting the dorsal abdominal segments of the pupa and adult.)

In sections of a larva a day or two after hatching, the fat-body consists of large, often free cells, each containing a single nucleus, and with the protoplasm well vacuolated (fig. 20), They measure about 8–12 micra in diameter, and all appear histologically similar. A larva sixteen days old shows fat cells (fig. 21) which are frequently more or less united into sheets or

layers. The cells are now more irregular in form, and measure about 10–16 micra in diameter. They often contain a few spherical proteid bodies with deeply staining centers. We find that in sections of a second-year larva, the fat cells are much larger and are massed into spherical or subspherical bodies (fig. 24, *FB.*) which occupy a large portion of the body-cavity. These fat-spheres measure about 60–160 micra in diameter, though they vary considerably in size. Their constituent cells have thin and often ill-defined walls, so that the mass may look much like a syncitium. Each cell has a single oval or subspherical nucleus which is surrounded by a small amount of protoplasm The rest of the cell is filled with blue-staining proteid bodies as well as fewer pale brown ones of the same size. These bodies, which range from 1.16 to 4 micra, are usually spherical, but may also be oblong, or both oblong or crescentic. In addition, very small yellowish-brown granules, resembling coagulated plasma occur in the fat cells. But the fatty substance itself has all been dissolved away in the fixing and staining, and this also appears to be the case with the urates. The fat-body occupies the greater part of the body cavity, where it often appears as a loose and irregular perivisceral sheet. Isolated fat-bodies are also found and seem to be quite similar to those which occur in the larva of Lampyris noctiluca, as figured by Hollande ('09). No breaking up of the fat-spheres, such as is found in pupating larvae and in pupae, was observed.

Situated especially near the insertions of the dorso-ventral oblique muscle bundles are often more or less compact groups of large haemocytes or blood-cells. These may lie in part on the hypodermis, but they are usually separated from it by a small or even a considerable space, and may sometimes occur near the center of the body. Apparently similar cells have been studied in Apis and Vespa, by Anglas ('00) among others. He does not attribute to them a phagocytic function, but thinks that they may grow at the expense of the degenerating muscle. At any rate they do not appear to be involved in the formation of the photogenic organs. A sagittal section shows clearly that these haemocytes are segmentally arranged.

The fat-spheres which are situated in the ventral portion of segments six and seven of the abdomen, and are one or two rows deep (*A*, figs. 24 and 25), are destined to give rise to the photogenic organ, and may therefore conveniently be called the photogenic fat-spheres. The most ventral of these sometimes lie directly upon the hypodermis. The longitudinal segmental muscles span these and other fat-bodies. None of the photogenic fat-bodies are among those of large size, such as commonly occur in the mid-abdominal region.

The first change observed in the photogenic fat-spheres takes place a short time before the larva enters the pupal stage. In the case especially studied (fig. 24) the larva was quite active and bore no evidence that it was soon to pupate. (It may be said here that pupating larvae and pupae were never found to possess a general effulgence as is noticeable in Photuris pennsylvanica, where even freshly emerged adults glowed in the thoracic region. I do not believe that this phenomenon is involved in the formation of the light-organs.) Here the photogenic were found to differ from the other abdominal fat-bodies, first, in taking the stain a little more deeply, second, in having more distinct walls, and third, in having larger nuclei. These changes are in general, fairly evident in a sagittal section.

The next stage observed was the partial envelopment of the photogenic fat-bodies by a layer of yellowish-brown material, staining much like plasma or dermis (figs. 17, 18, and 24). This does not seem to be a secretion from the fat-body as it lies wholly outside the latter. It is at first fairly homogenous, save that there are small black particles along the inner border. It is not improbable that this cap-like layer partially enveloping the fat-body and diminishing in thickness along the edges, is formed from material in the blood, which, together with certain haemocytes, has been attracted to one side of the fat-body by some substance, and has thus come partially to invest it.

The fact that the blood-cells (figs. 17 and 18) are almost always in contact with this investment and not applied elsewhere to the fat-body, would seem to indicate that these bodies exert a certain attraction. Here also coagulated plasma gathers

in the form of yellowish-brown granules. The affinity of phagocytes for the fat-body is a common feature during the metamorphosis of insects. It is claimed that phagocytes may penetrate the fat-body itself, but this does not occur in the case under consideration. It must not be supposed that the photogenic fat-spheres alone are thus affected, nor perhaps that they all have such an investment. On the contrary, partial investment and attraction of haemocytes is far more common in the fat-spheres of the thoracic region and is rather infrequent elsewhere.

Probably the explanation for this is that in the thorax and in the photogenic area, and perhaps also at the caudal extremity, histolysis and histogenesis are much more vigorous than elsewhere. In the head and thorax, at the time of pupation there is a great alteration in the musculature and in the appendages, and some in the nervous system, as well as a great alteration in the body form, but these changes are not so pronounced in the abdominal region, at least as regards the musculature. The photogenic mass with its extensive tracheation must be quickly built up over a large area. It is the direct product of the fat-body, as we shall presently see. The haemocytes, *FB*, associated with these fat-bodies are quite different—usually in size and certainly in appearance—from the segmental blood-cells (figs. 17 and 18). They were not recognized in larvae of the first instar, where the segmental blood-cells were quite marked, but occurred very abundantly in large larvae and in pupae. While the segmental blood-cells are comparatively local, and perhaps rather inactive, the fat-haemocytes, as we may term the others, have a far more scattered distribution throughout the body and are frequently in contact with some tissue. The segmental haemocytes are on the average larger (8–13 micra), more regularly rounded, deeply-staining granular cells, with large nuclei and few or no vacuoles; the fat haemocytes on the other hand, are usually smaller (5.8–12 micra), decidedly vacuolated and therefore of lighter color, with smaller, often irregular nuclei, and though commonly spherical or nearly so, they frequently exhibit amoeboid processes.

In later stages they often mass together, thus somewhat resembling a tissue. They are intimately connected with the fat-body at certain stages and evidently play an important part in the histolysis of muscles, especially those of the thorax. In this region they apply themselves closely to the muscle tissue, though none was found penetrating or ingesting it. Except for their smaller size and the often more irregular shape of their nuclei they much resemble incipient fat-cells. They are naturally more abundant in the pupal stage than at any other time. Blood-cells were very seldom found in the process of division, and when in this condition it was difficult to determine the kind of haemocyte which was under observation.

The partially investing cap as well as the fat haemocytes seem to be instrumental in the breaking up of the fat-body, either into separate cells, as is largely the case in the luminous tissue, or into scattered food particles for the various organs, as was noticeable in the head and thorax. It is noteworthy that in the case of the photogenic fat-spheres the investment is usually on the side next to the alimentary tract, so that when the fat-cells are liberated they are able immediately to migrate to the body wall and there form the photogenic layers. By the inflection of the cap or investment, the fat-sphere is squeezed or constricted at that point till the thin membrane opposite can no longer withstand the pressure, when as a result the fat cells are ejected in masses (fig. 24), and presumably also singly. The pressure exerted often serves greatly to attenuate the nuclei, but no cell division could be detected during the process. Very rarely, and then only in the case of a thoracic fat-sphere, were the cells seen to be liberated through a rupture of the cap. Vogel ('13) has described the breaking up of the fat-body in Lampyris noctiluca, to form the photogenic tissue. The envelope of the fat-body is ruptured, probably through the activity of neighboring leucocytes, and from the old membraneless nuclei of the fat cells arise new ones which are richer in chromatin and possess a distinct nuclear membrane. One might say that the nuclei regenerate, for here there is considerable mitosis, especially on that side of the photogenic fat-bodies which is nearest the hypodermis.)

As the fat cells become more and more expelled, the investment thickens and the number of fat haemocytes often increases to such an extent that in their crowded condition they become noticeably squeezed and attenuated, and form a mass several rows deep (fig. 18), the outer haemocytes being more rounded, the inner closely applied, in a roughly radial fashion to the investment. They frequently contain fine yellowish granules, such as occur in the fat and also constitute the blood plasma.

The ultimate fate of the investment and what may remain of the fat-body within was not definitely ascertained. I often found in sagittal sections through the thorax of pupating larvae, groups of much reduced investments (*I*, fig. 19) circular or U-shape in outline, according to the section, and sometimes containing a network of cytoplasm or a few proteid granules and what seemed to be waste matter. Such investments were still at least partially surrounded by the much vacuolated fat haemocytes whose irregular outlines and frequently attenuated and eccentric nuclei would seem to indicate a degenerating condition. It appears probable that the investments disappear before the adult condition is reached. They were not well defined in the less studied Photuris larvae.

The photogenic fat cells which are set free in this manner are large. Their nuclei soon round up considerably. They still contain the large blue-staining proteid bodies so conspicuous in the fat-body proper. The cells (*P*, fig. 25), as yet undifferentiated, migrate to the body wall and apply themselves to the hypodermis, *H*, where they form an uneven layer. Even at this early stage of development in pupating larvae, some of the tracheal branches, arising from the large stigmatic stem invaginated from segments six and seven, push through the photogenic tissue, even to the hypodermis. But the tracheae in the photogenic tissue are not yet differentiated, for they resemble those in other portions of the body (*T.* figs. 24, 25 and 27). In a later stage (fig. 27), it is three or more cells deep, and, though the mass is still rather indefinite, it begins to show a differentiation into two layers. The cells have become denser, containing as they do rather sparse little pale yellow granules and a fine net-

work of cytoplasm. The nuclei, though large, are not so sharply outlined. Furthermore, many of the blue-staining proteid bodies have disappeared. Vogel ('13) in speaking of the contents of the fat cells of Lampyris larvæ, mentions these albuminous granules as the chief inclusions. This reserve material he says, much resembles in staining and refraction the yolk spheres in the egg. He describes the transformations of the albuminous inclosions of the fat cells into the photogenic granules as follows, p. 331:

> Von Wichtigkeit ist nun das Schicksal dieser Dotterkügelchen in den zur Bildung der Leuchtorgane bestimmten 'Fettzellen.' Dieselben werden nämlichwohl unter Einwerkung von Enzymen—zerstrummert, wobei Vacuolen (Wasser?) in ihnen auftreten. Die Bruchstücke werden sodann immer kleiner, und schliesslich kommt es dahin, dass wir in den Licht produzierenden Leuchtzellen nur ganz feine eosinophile Granula vorfinden, dass wohl, da sie sich in jedem Leuchtgewebe der Lampyriden finden, den 'Leuchtstoff' rapräsentieren dürften.

I have been unable to account for the disappearance of the blue-staining proteid granules (albuminous inclusions) in this manner. It seems to me as if they were first dissolved and used up as food and that the smaller, photogenic inclusions were but the indirect product of the first, just as this reserve material contributes to the formation of various tissues in other parts of the body.) The outer photogenic (peripheral) cells—those which are the seat of luminescence—are already larger than those of the scarcely differentiated upper or reflector layer. Nerves, presumably from the last two abdominal ganglia (as in Photinus marginellus, as described by Townsend) and supplying the photogenic tissue, were found at about this stage. They were few in number and quite slender. A single branching nerve extended to a tracheal invagination and could be followed up to the photogenic tissue, which it penetrated. Bongardt ('03) states that in Lampyris splendidula he found nerve fibres in the tracheal end-cells. Geipel ('15), who gives good detailed descriptions and illustrations of the light-organs of Photinus marginellatus and Pyrophorus noctiluca, has found in the former insect a fine nerve penetrating the tracheal end-cells and going

into the nucleus. This is noteworthy, especially from a physiological standpoint, for it indicates that the end-cells are the important mechanism for stimulating the light production.

In the newly-formed pupa a decided advance in development is observed (fig. 28). The two layers can now be clearly separated. The cells of the photogenic layer, *P*, are more spherical, have increased in size and in density of contents, and the nuclei, though larger, are less sharply defined. All of the blue and brown granules, once so abundant, have disappeared, and, owing to a fine knotted network of cytoplasm, the cells have a rather granular aspect. It seems probable that the cells of both layers divide, since the cells of the fat-spheres involved in the formation of the organ seem not to be sufficiently numerous to preclude a later proliferation. The cells of the luminous layer are larger and rather more regularly arranged than those of the non-photogenic layer, *U*, which has resolved itself into several layers of smaller, clearer, more or less flattened cells.

The differentiation of these two layers is further accentuated by the development of the 'tracheal end-cells' which are almost certainly formed from the tracheal epithelium in the lower or photogenic layer. Tracheal end-cells, so named by Max Schulze ('65) who studied exhaustively the light-organs of the European Lampyris splendidula, are cells whose cytoplasm envelop, at least basally, the tracheoles or fine terminal, capillary tubules of the tracheæ. The tracheoles, though chitinous, lack the tænidial thickenings characteristic of tracheæ. Figure 23 illustrates a tracheal end-cell, modified from a sketch by Lund ('11), of the photogenic layer. Holmgren ('95) uses the term 'transition cell' (Übergangszelle) for these end-cells, since he claims that they are not the terminal cells, for there exist other very small and elongate cells distad to them. Townsend ('04) uses Holmgren's term. At any rate it seems reasonably certain that the tracheal end-cells are really terminal in the Lampyridae. (Tracheal end-cells are not peculiar to the photogenic organs of insects but occur in other tissues, such as the spinning glands of Lepidoptera, in the Malpighian tubules of Hydrophilus piceus (Schneider, '02), in the fat-body (Schneider, '02, Thulin, '08),

in the crop of Blattidæ (Petrunkewitsch, '99), etc. Geipel ('15) however was unable to find distinct tracheal end-cells in the luminous elaterid (Pyrophorus noctiluca). The end-cells have their cytoplasm continuous with the tracheal epithelium on the one hand, and on the other, spread far along the tracheoles, if they do not entirely envelop the latter.

In general, the tracheæ (*T*, fig. 28) which supply the light-organ, extend transversely from spiracle to spiracle and are connected by lateral branches, well illustrated by Geipel ('15), over the dorsal layer and send down numerous, usually vertical branches through the organ. The epithelium which invests and secretes the chitinous intima of the tracheae, is, in the non-photogenic layer, as elsewhere without the organ, rather thick, with numerous deeply-staining nuclei which lie parallel to the length of the chitinous tube itself, already being secreted at this stage. In the photogenic layer however, the tracheal epithelium is much thicker (*E*, fig. 28), for here the cells are not parallel to the length of the tube but have their long axis at right angles to it. The nuclei are in the distal portion of the cells. It is in this region that the tracheal end-cells are formed. They occur on the numerous little lateral branches which radiate from the vertical trunks (*EC*, fig. 29), and are close together or contiguous, thus forming a sort of outer cylinder investing the now thin tracheal epithelium on the one hand, and on the other, closely applied to the surrounding photogenic cells. The tracheoles most commonly bifurcate and anastomose, and may often appear in cross section as thick rings between the photogenic cells. Geipel ('15) who has carefully studied the end-cells in Photinus marginellatus, concludes that the capillary ends blindly in the middle of the end-cell; that there is no direct connection between this capillary and the processes of the end-cell, that these processes do not anastomose, and finally that the latter are intercellular. Having no osmic acid fixations of this material I am unable to add anything to these disputed points, except that I have found no end-cell processes penetrating the photogenic cells, but have found them to be intercellular. These processes, at least in a number of cases, almost certainly do anastomose,

and this is a common occurrence in end-cells elsewhere than in the light-organ. This can be shown in fresh preparations treated with caustic potash.

In a freshly formed pupa the tracheal end-cells have not yet been differentiated from the thick tracheal epithelium, but cell division seems to be more frequent in the portion of the epithelium immersed in the photogenic layer than elsewhere along the trunk, and it is likely that some of these dividing cells ultimately migrate from their original position along the main trunk, beyond the small branches containing taenidia and secrete the branching tracheoles. The fact that the tracheal epithelium is especially thick in the photogenic layer would seem to strengthen this interpretation. (Geipel found some tracheal end-cells in the urate or upper layer of the light-organ of Photinus marginellatus). Still the examination of numerous sections has failed to reveal two sorts of tracheal cells such as occur in the adult.

The photogenic organ, when in the process of formation, frequently suggests a hypodermal origin, for it is then rather structureless and closely applied to the body wall. Indeed some sections show the hypodermis sending up extensions between the cells of the organ. This is perhaps one of the reasons why Dubois ('98) believes that the photogenic organ, at least in Pyrophorus noctiluca and in Lampyris noctiluca, is derived by direct proliferation from the underlying hypodermis. It seems to me more logical to suppose that, as in Photuris and Photinus and Lampyris, the light-organ of all Lampyridae is derived from the fat-body. But unless a complete series of the developmental stages is at hand, it is unsafe to speculate on the origin of the light-organ. A careful examination of the initial stages, I am sure, will convince anyone that the hypodermis has nothing to do with the formation of the light-organ and is distinctly separated from it. The cells of the hypodermis contain no blue-staining proteid granules as do the photogenic cells at first (figs. 25 and 27), and they also appear much too small to give rise to these large cells.

The fat haemocytes were not found to enter or become engulfed in the light-organ, though they could often be seen lying near or against it (*FB*, fig. 28) In this figure the organ is not yet functional, as two or more days in the pupal stage are required before the photogenic power is apparent. By that time the tracheal end-cells are sufficiently developed to supply the necessary amount of oxygen. In the adult firefly the two layers of the organ (*U* and *P*, fig. 29) are so different in appearance as almost to preclude the possibility of a common origin. They are not separated by a membrane and no intermediate conditions between the two layers were observed. The upper or urate layer, *U*, still much resembles adipose tissue, the cell boundaries are well marked and the nuclei distinct, at least in the beginning when the pale granular deposit (urate?) is small. The cells of the lower or photogenic layer, *P*, have become filled with small photogenic granules (0.29–0.58 micra in diameter) thus obscuring the nuclei to a certain extent. These granules are black and are not distinctly spherical; they gradually increase in number and soon render the cells very dark and often obscure their outlines. But the cell peripheries contain no such granules and are therefore much clearer in color. The tracheoles were not found to penetrate the photogenic cells, but the processes were observed to bifurcate and sometimes to anastomose. They are best studied when prepared in caustic potash or osmic acid. Max Schultze ('65) on treating the capillaries of the tracheal end-cells with gold chloride, found them to be hollow to the end, and in life to contain a liquid.

A horizontal section through the photogenic layer shows thick blackish rings forming a sort of network. These rings represent the photogenic cells, separated one from another by pale thin lines. Within each ring is another pale brownish one representing the tracheal end-cells and epithelium, while the central clear space is the vertical trachea. A freshly dissected organ, as seen from the ventral side, shows a somewhat reversed condition, for here the ring of photogenic cells, and probably also the tracheal end-cells, will be found luminous and the enclosed area, the tracheal cylinder, non-luminous.

The two vertical muscle bundles (*M*, fig. 26) which partly divide each photogenic organ, persist, with some changes, from the larva to the imago.

The adult photogenic organs of Photinus have been well described and illustrated by Townsend ('04), and Lund ('11), and by Geipel ('15) in Europe.

The larval light-organs begin to deteriorate at least in the pupal stage; the photogenic layer seems to be the first to break up with a disappearance of the nuclei, the layer becoming filled with small black granules or rods. Evidently this is the condition of the photogenic organ (fig. 30) in the adult Ellychnia corusca, a lampyrid not held to be luminous in the mature state. Dubois ('98) in speaking of the European Lampyris noctiluca, says, p. 321: "Les organes larvaire persisteront après la transformation de la nymphe, soit en insecte mâle, soit en insecte femelle; . . . . "

DEVELOPMENT OF THE LARVAL PHOTOGENIC ORGANS IN PHOTURIS PENNSYLVANICUS

Owing to the minuteness of this organ, and to the inferior differentiation of the embryonic tissues, the development of the larval light-organs could not be followed with the detail and degree of certitude which the growth of the adult light-organ permitted. It is evident however that as a definite structure, it is formed quite late in the development of the embryo, i.e., when the latter lies in the final curled-up position (fig. 45). It is not improbable that in the earlier stages the light, being diffuse, arises from the yolk granules. Vogel ('13) has made some observations on the development of the photogenic organs in the embryo Lampyris noctiluca. He recognises the fatty origin of the organs, and suggests that the source of luminescence is in the yolk, which in its changes, etc., much resembles the proteid inclusions of the fat-body in old larvae. He studied the light-organs in late embryos (18 days incubation) and states that they do not arise from imaginal discs.

It is only late in the embryonic development that the two larval lights are discernible through the egg-shell. Long after

the oenocytes, whose compact and appressed segmental clusters (*OE*, fig. 51) much suggest light-organs, have migrated from the body wall into the body cavity, and the fat-body and haemocytes have become differentiated, but before the cuticula and hairs have appeared, the photogenic organ (*O*, fig. 15) is discernible as a compact mass of rather large, distinct and well-nucleated cells, lying on each side in the eighth abdominal segment, between the anterior end of the segment and its tracheal invagination. The organ is closely applied to the hypodermis, but is nevertheless distinct, though the hypodermis is quite thin where it is in contact with the organ. This fact might suggest that the hypodermis gave rise to the light-organ, but the former is of variable thickness and its cells are quite unlike the nearest cells in the light-organ. These moreover, do not appear to be the youngest cells, as should be the case were they of hypodermal origin, as Dubois affirms of Lampyris noctiluca. On the other hand, the inner cells, i.e., those nearest the fat-body, which appears almost as a syncytial mass, greatly resemble those fat cells (*A*, fig. 15) with which they are in contact. They are more vacuolated here and this suggests their fatty origin. The whole cell-mass is approximately spherical and measures about 17 by 21 micra. The cells for the most part are already differentiated from the fat-body, as their protoplasm is denser and contains small yellowish-brown granules. The cells are also smaller in size. No tracheae as yet penetrate the organ, nor could nerves be found in connection with it. A large cylinder of tracheal epithelium *T*, is near, but has as yet secreted very little or no chitin. The stage of development above described could be found in but a single specimen. The cells indicated a spiral arrangement and gave no indication of the two layers. No blue-staining proteids occurred either in the fat cells or in the light-organ; the yolk mass probably furnished much of the food material.

A considerably later stage of development (fig. 14) is to be found in the well-chitinized larva, with hair, spines and appendages completely or nearly completely developed. Such larvae are capable of moving within the egg-shell, and their photogenic organs appear through the latter as two points of light. The

tracheae, *T*, have already been secreted by the flattened epithelial cells.

The light-organ, which is now quite free from the underlying hypodermis, has assumed a slightly oblong form, and is held in position at several points by membranous strands resembling connective tissue. An outer, somewhat paler layer of cells, *U*, is now obscurely visible, and appears to surround the entire, denser inner mass, *P*, the true photogenic tissue. This seems to be more reticulate than granulate, though in neither zone are the cells themselves clearly discernible, as in the earlier stage, though their nuclei are regular and distinct. It is probable that by this time the organ is functional. It is supplied by a trachea and perhaps a nerve. The fat cells (*A*, fig. 14) are large and vacuolated, with somewhat collapsed nuclei, and contain no blue granules such as are found later. They sometimes lie free in the body cavity like haemocytes, but may also be united into masses. The fat-extruding or -squeezing process through the agency of a partial encasement, described in old larvae and in pupae of Photinus consanguineus, was not observed to take place in the embryo, but such a process seems unnecessary here, since the fat-body has many free cells and is otherwise of a much looser structure than in the later stages. The organ now measures about 24 by 34 micra.

In the second-year larva the organ (fig. 16) is about 577 micra in its longer and 451 micra in its shorter diameter, and is broader than high. The whole is enclosed in a delicate, non-cellular membrane by which it is secured to the attenuated hypodermis and there flattened. The hypodermis is now very much thinner than the cuticula. The two layers are well differentiated, but it is evident that the organ is by no means as definitely and highly developed as in the adult. While the light-organ is under control of the larva, in that it can be extinguished and made to glow, this operation is incomparably slower and therefore less perfect than in the adult, where the stimuli are apparently to a large extent transmitted through the optic nerve, a structure which is of course also better developed in the adult.

The inner layer (or rather, mass) is surrounded dorsally and laterally by the thinner outer sheet, and is ventrally applied to the hypodermis, its cells are ill-defined, with distinct nuclei, and the cytoplasm contains numerous, very fine black granulations, about 0.29 to 0.58 micra, which are thus of the same size as those in the adult light-organ. This photogenic mass is quite distinctly separated from the rather clear, more feebly staining outer sheet, which is one or two cells in thickness, the outer being tall and columnar and radially arranged around the center of the organ. These cells of the outer (reflector) layer are all well-defined and filled with small pale granules. At least one large tracheal branch and one fair-sized nerve (*T* and *N*, fig. 13, Photinus consanguineus) enter the outer and penetrate the inner mass by a well-defined pore. The nerve is a branch from the most ventral of the three pairs which proceed from the last (eighth) abdominal ganglion. The latter is situated in the fifth abdominal segment. The trachea involved branched considerably within the organ, and terminated as tracheoles (fig. 22) of much slenderer proportions than those in the adult light-organs (fig. 23). No end-cells were found. The capillaries or tracheoles extend throughout the photogenic mass in an intricate and irregular fashion, so that the tracheal cylinders are not evident.

The larval light-organs are essentially similar in Photinus and Photuris. When freshly dissected the dorsal layer is dead white, and the lower a sort of very pale yellowish green or gray and semi-translucent.

PHYSIOLOGY OF THE PHOTOGENIC ORGANS

It is needless to say the study of photogenic organs from a physiological standpoint has proved to be a subject of unusual interest, especially since it suggests, even to the casual observer, the possibility, however remote, of using the luminous powers in the organic world. The fact that "no sensible heat accompanies the fireflies' light," and that "nature produces this cheapest light at about 1/400 part of the cost of the energy which is expended in the candle flame" (Langley and Very, '90), opens a very inviting field in both pure and applied science.

The photogenic organs in fireflies (Lampyridae) and the neotropical elaters of the genus Pyrophorus are perhaps the most efficient and highly specialized of all photogenic tissues, and for this reason, as well as because of their general abundance they have for years been the favorite objects of study in this field.

Förster ('82) advanced the hypothesis that the luminous material of the Lamypridae was phosphorus dissolved in the animal fluids. He found that the Lampyridae shone more intensely in pure oxygen than in air.

According to Lindemann ('63), Treviranus explained the luminescence in these insects by stating that the fat-body absorbed phosphorus. Treviranus ('18) says, p. 109: "Der Einfluss des Thiers auf das Leuchten geschieht mittelbar, durch das Athemhölem," and further: "Das Ausstrohmen des Lichts hangt daher von der Wilkuhr des Kafers ab." Treviranus found no nerves going to the luminescent mass.

Another of the older explanations of the phenomenon of light production, is, according to Lindemann, that held in the beginning of the nineteenth century, by Monti, Carradori and Beccaria, who thought that fireflies were light-absorbers (thus comparable to certain minerals) in having the power to take in the sunlight, and in the night, to give it out again.

Michael Faraday ('14) made some interesting observations on the luminescence of the firefly and glow-worm. He was of the opinion that the light "has a dependence on the respiration" . . . . and that the light-giving power seemed to depend "more on the chemical nature of the substance than upon the vital powers of the animal." He found no sensible heat accompanying this production of light.

From the middle of the last century, with the advance in chemical and physiological research and the perfection of the microscope, the phosphorus theory was soon abandoned, to be replaced to a large extent by one of the oxidation of an albuminous substance, and this with some modifications is the general view of the present day.

As early as 1857, von Kölliker was able to analyze the two component layers of the photogenic organ, the inner or non-

luminous layer of opaque (weisse) cells containing birefractive crystals of ammonium urate, and the outer (blasse) clear cell layer containing an albuminous substance. Von Kölliker found both nerves and tracheae branching into the lower (outer) layer. He states that the luminescence is the accompaniment of the oxidation of the luminous material and that this oxidation is under the direct influence of the nervous system.

Lindemann ('63) states that the so-called phosphorescent spheres (Phosphorkugeln) are found in the fat-body of all insects, where they never shine, though their chemical composition is the same, and concludes that these bodies are not the real seat of luminescence.

Schultze ('65), and Owsjannikow ('68) made important physiological contributions, the former making good use of osmic acid for the finer study of the tracheal end-cells.

Heinemann ('86), among others, recognizes that moisture and oxygen are essential for the light-production and thinks that the light is not ascribable to the living protoplasm itself but to one of its products, which shines on contact with oxygen brought in by the tracheal capillaries. The light process goes hand in hand with the production of a brownish-yellow material which is diffusely distributed in the cell material.

Seaman ('91) says that the phosphorescence in the firefly coincides with the inspiration and exhalation and not with the movements of the heart. He devotes much space to the chemistry and physiology of the light-organs. He says, p. 143: "It is by means of the muscles that act as intermediaries that the nerves regulate the photogenic function." Respiration, he says is only an indirect control.

Dubois ('98), in his extensive studies on animal luminescence, holds views quite different from the men of his day and of the present time who have studied the phenomenon. He states that the cells of the upper or non-photogenic layer are nothing more than the cells of the luminous zone which have undergone histolysis. He does not attribute to oxygen the primary role but only the capacity it plays in other tissues (reducing agent), and holds that the luminescence is caused by the conflict of two sub-

stances, the first he calls luciferase, resembling an enzyme and resulting from the granular degeneration of bioproteon in the photogenic cells, the second substance he calls luciferine, which he obtained in an impure state (and had not then analyzed) he thinks occurs in the blood throughout the body, and considers it to be non-living material, inasmuch as it can withstand temperatures incompatible with life, with the addition of oxygen and water. (Later ('11) Dubois abandoned these two terms, which he states were provisional and which gave rise to disputes of a compromising nature.) As a passageway for the blood carrying the luciferine to the photogenic organ he figures large spaces or cracks in the latter. The existence of such spaces seems improbable, as they do not appear to have been observed by any of the subsequent students. Lund ('11) believes that the spaces are "nothing but the region of the vertical cylinders and tracheae which sometimes do not stain readily." Dubois bases his conclusions largely on the luminous bivalve mollusc, Pholas dactylus L.

Wielowiejski ('82) thought that the tracheal end-cells in the luminous layer, as well as their tracheal matrix were analagous to the red blood-corpuscles of vertebrates. The oxygen of the air going into the tracheal capillaries would be absorbed and given over to the proper photogenic cell. The nervous system would excite the parenchyma (photogenic) cells to secrete, and photogeny would be a process of simple oxidation.

Bongardt ('03) repeated the various experiments of Dubois but obtained somewhat different results. He holds that Dubois' experiments were often of too short duration, and perhaps the gases used too impure to give trustworthy results. Bongardt made an extensive study of the physiology and the finer structures of the photogenic organ. He found many nerve processes entering the photogenic layer, following the tracheae, but unlike Owsjannikow, never found nerves penetrating the cells themselves, although he did find them penetrating the tracheal end-cells. He considers the luminescence in the Lampyridae to be a secondary phenomenon.

Kuhnt ('07) suggests that possibly the light produced by Lampyridae is bacterial.

Dahlgren and Kepner ('08) say with reference to the tissues of photogenesis that: "The power is probably a specialization of the same or similar processes to those that produce heat, motion, and electricity." They do not accept the theories of Dubois and do not consider the luciferine of the blood, but oxygen, the reducing agent in photogeny. Of the luciferase of Dubois they say: "It can be seen in sections and teased cells as a collection of granules that stain very readily and retain the stain with great tenacity."

Lund ('11) studied the light-organs in fireflies from a structural and physiological point of view. He is of the opinion that the process of photogenesis is dependent upon the presence of a substance, probably of the nature of a reductase, in the presence of water and oxygen, and that it is probably an oxidation process. He determined that the dorsal layer of the photogenic organ became "the repositories for the waste product" (of the lower layer) and that

> From the facts concerning the relation, in amount, of the granular deposit in the dorsal and ventral layers it is evident that we are to consider the granules of the photogenic cells as at least one if not the main source from which the crystalline (urate) deposit is derived. . . . . From a study of the dried photogenic material we at once see, as others have long ago pointed out, that the immediate process of light production is not dependent upon the protoplasm of the cell but upon the interactions between formed substances.

Harvey ('14) studied the chemical nature of the luminous material of the firefly and believes that the phosphorescence is due to the oxidation of some substance formed in the cells of the animal. He says in part: "I can state definitely that the 'luciferine' of the common firefly is not a true fat or any fat-like body such as lecithin. . . . . The material is therefore insoluble in fat solvents. . . . . It is most likely a protein but belongs among the proteins insoluble in water."

Pierantoni ('14), and Buchner ('14), think that the photogenic organ may be a luminous bacterial structure. Buchner states that in bacterial symbiosis in Coleoptera thus far observed, the infection is through the mouth of the insect. (Dubois has made numerous attempts to determine if possible whether the photo-

genic granules were bacteria, by trying to make cultures of these granules in a number of different media. All his results were negative.)

Geipel ('15) who has published perhaps the best account of the structure of the photogenic organs in beetles, agrees with Bongardt when he says that the nerves to the photogenic layer terminate in the tracheal end-cells and not in the photogenic cells. Thus it would seem that the oxidation process for photogenesis is activated through the agency of these end-cells.

It seems clear that while the photogenic organ in the Lampyridae is derived from adipose tissue, the luminous substance itself is not fat-like, but is probably a protein contained in modified fat cells (the luminous layer) in the form of minute dark-staining granules. Such granules evidently occur in all true photogenic tissue.

Almost numberless experiments have been performed with fireflies to determine if possible the manner as well as the purpose of the light production. An old and important discovery is that when the photogenic organ when dissected out and dried, it will, months thereafter, shine in the presence of air and moisture, showing that these substances are essential to luminescence, and that the process may be independent of living protoplasm. But the very fact that it is produced by protoplasm (plus oxidation) which is not generally admitted to be a merely physicochemical combination, would necessarily entail a vital activity of some sort. That the luminescence is controlled directly by the nervous system and not immediately through muscular activity (abdominal respiratory movements) seems clear from experiment as well as from the fact that glandular structures in general (including the electric organs of fishes) are dependent for their activity upon nerve control. Luminous organs may also respond locally to mechanical stimuli. It is easy to determine that the respiratory movements do not correspond to the periodicity of the light, and as Lund and others have shown, there is no special musculature for the photogenic tissue. Nor does it seem probable that the light is controlled by the flow of blood, as claimed by Dubois. This could hardly account for the rapid and well-

defined flashes of light and would necessitate the control by a well developed system of muscles of large passages (which do not exist) in the light-organ. Lund severed the nerve cord of *Photuris* and found that the insect lost control of the photogenic organ; at most a faint residual glow persisting after the operation. In a similar experiment on the larva of this insect I found that the light would quickly lose its brilliancy and finally disappear.

That the luminous substance is at certain periods also in a diffuse condition, i.e., not confined to a light-organ, is evident if one examine eggs which are not far developed. This diffuse condition is still better shown in pupating larvae and in pupae of Photuris pennsylvanica, and it even prevails in freshly hatched adults, where it is more clearly visible in non-pigmented areas, as at the sides of the pronotum. Effulgent pupae were cut in three pieces to make sure that the glow was general. Dissections showed points of light (granules) such as occur in the true photogenic layer. This diffuse light was more pronounced in the head and thorax, and did not supplant the true photogenic organs at any time. The dorsal vessel had no effulgence and it seems probable that the luminous granules are distributed at such times also in the yellowish-white fat-body which pervades the insect. Such a glow seems, so to speak, to be a necessary accompaniment of the rapid metabolism which takes place at this stage, and subsides as the development becomes the more complete.

Dubois (1886, p. 100) says, that at the moment of metamorphosis in the larva of Pyrophorus and in the pupa of Lampyris (when histolysis is much more rapid than at any other time) a diffuse glow spreads over the body. No such luminous phenomenon was observed in the larva and pupa of Photinus. It does not seem probable that these diffused photogenic granules finally collect in the light-organs, as do for example the bacteria in the mycetoms of Homoptera, but that they are used up in situ, the granules of the photogenic layer being formed in the cells of that organ itself.

The spectrum of the firefly has been studied by a number of men, among whom are Young ('70), Langley and Very ('90), and Dubois ('98). To quote Young:

> The spectrum given by the light of the common firefly of New Hampshire (Photinus) is perfectly continuous, without trace of either bright or dark. It extends from a little above Fraunhofer's line C, in the scarlet, to about F, in the blue, gradually fading out at the extremities . . . . precisely this portion of the spectrum is composed of rays, which, while they more powerfully than any others affect the organs of vision, produce hardly any thermal or actinic effect.

By dissecting out the light-organs in living specimens and then observing the same through the spectroscope a weak spectrum was obtained; by adding hydrogen peroxide to the photogenic organs the light, apparently unchanged in color, became more intense and steadier.

The purpose of the photogenic organs in insects has been much studied. McDermott and Mast, among others, consider the luminescence in the Lampyridae to be a secondary sexual character. Others offer the explanation that they furnish protection to the insect in their warning or intermittent light emissions. Olivier has made some interesting observations upon the secondary sexual characters of these insects and shows that there is a definite relation between the development of the photogenic organs, the eyes, and the antennae. It is the combination of these, and perhaps other organs which constitute a composite sexual character.

Inasmuch as the larvae of many Lampyridae at least, are gregarious, in that they inhabit defined areas, it is possible that in this case, luminescence may assist in the preservation of the colony.

The adults of luminous Lampyridae are known to have a rather well-marked periodicity in exercising their photogenic powers, shining normally in the evening and not being long deceived when placed during the day, in darkness. But Photinus pyralis has been known to fly and to scintillate in the darkness caused by the approach of a heavy thunder shower (see Laurent, Ent. News, XXV, p. 334, 1914). But the larva of Photuris seem to

have this character of periodicity less pronounced than the adult. Some of these larvae on being placed at 11 a.m. into a dark room, emerged from their hiding places, and while not glowing with their usual brilliancy, walked about and fed as if the evening were at hand.

NOTES ON THE EMBRYOLOGY OF PHOTURIS PENNSYLVANICUS

The egg (fig. 31) is subspherical, pale lemon yellow, and measures about 784 by 677 micra in diameters. It has three envelopes; first, a thin outer membrane which encloses many fine oil-like drops and gives the surface a granular aspect; second, the chorion, the stoutest and firmest of the envelopes; and third, the vitelline membrane, a secretion of the egg itself. The dorsal and ventral sides of the egg appear similar, but the longer axis evidently marks the anterior and posterior poles. I could find but a single micropyle, and this was to one side of the presumably anterior pole.

I have no stage which shows the formation of the blastoderm, or peripheral cell layer. Figure 32 is a section through an early blastoderm stage. No cell walls are visible, the cells being flattened against the vitelline membrane on the one hand, and on the other they bulge inwardly. The vitellophags or yolk cells (*V*, fig. 32, and fig. 42) are considerably larger than the blastoderm cells, and are often amoeboid or stellate. They are not very abundant in the stage figured, but later they increase in number, and doubtless, through the agency of protoplasmic processes, form an extensive network.

Embryonic envelopes. The amnion and the serosa appear before there is any indication of a gastrula. This is clear from figure 33, where the amnion, *A*, is thicker than the more flattened serosa, *B*, and merges almost imperceptibly into the somewhat thicker germ-band proper, *G*. A dorsal view of the embryo at this stage is shown in figure 34. It is about 245 micra long and is thickly almond-shaped, depressed, the broad blunt end being the cephalic one. The paler diamond-shaped area represents the point of contact between the amnion and the serosa.

A few cells may protrude into the amniotic cavity (fig. 33), at the point where the closure of the folds is effected. The cells of the blastoderm (the peripheral cells shortly separated from the embryo and commonly termed the serosa) have fairly distinct walls and are fusiform-flattened. The yolk, *Y*, which stains very deeply, is massed into subspherical bodies about 0.6 to 6 micra in diameter, and the vitellophags are much less evident, though now probably more numerous. Yolk granules may occur in the cells of the germ band as well as in the blastoderm.

Before gastrulation, the embryo both lengthens and broadens considerably, though its dorso-ventral thickness increases but little. Heretofore quite straight in its long axis, it curves dorsally and thus partially embraces the yolk-mass. It appears constricted before its middle, because the anterior portion has been broadened and furrowed to form the procephalic lobes (figs. 35 and 36). It is now about 263 micra in its straight length. It has become separated from the serosa, and, sinking towards the center of the egg, becomes a germ band of the immersed type. (Quite late in development, the amnion and the serosa come in contact in a comparatively small area in front of the mouth, (fig. 52)). Here the amnion and the serosa are separated from each other by an intermediary mass of yolk. This condition is represented in a later stage in figures 51 and 52. It seems that the immersed type of germ band is unusual in the Coleoptera. According to Korschelt and Heider ('99) the germ band of Coleoptera ". . . . is superficial and is grown over by the forward extension of a caudal fold and paired cephalic folds. . . . . The posterior end of the germ band on the contrary develops entirely according to the invaginated type." But later, by shifting, the germ band becomes totally superficial. Such a condition is found in Hydrophilus and Lina (Graber), Chrysomela (Strindberg), and probably in others.

Figure 37 shows a later stage of development. Segmentation is not yet apparent, but the embryo has greatly increased its size and curvature, for it now measures 390 micra in its full length. The cephalic lobes, *P*, are wide and separated anteriorly by a deep cleft. The amnion, *A*, forms a stout envelope,

and is especially thick at the caudal extremity, where it is often two cells in thickness. It merges gradually on each side into the germ band. The latter has as yet scarcely reflexed its borders towards the yolk-mass, but the gastrula, which is of an invaginated type, has already closed its lumen or central cavity, although it is still recognizable as a groove over most of the germ band. The invaginated portion seems to consist altogether of homogeneous mesoderm.

The next stage observed was the beginning of metamerization. Two small lobes (*L*, fig. 38) on each side of the median line represent the labrum, a clear central space the mouth, while a pair of subangular projections, *F*, the antennae. The latter already bear indications of segmentation and constitute the posterior portion of the cephalic lobes. All of the remaining segments have rather uniform proportions, and their appendages, including the first abdominal, are inconspicuous swellings. The amnion has become a thin sheet and remains such from now on. By the dorsal flexure of the sides of the embryo, the point of origin of the amnion has been moved towards the dorsum, where it is sharply marked off from the thick ectoderm (compare figs. 46 and 48). The serosa, which lines the interior periphery of the egg, is, like the amnion, a flattened sheet, but its cells are far larger and less attenuated than those which compose the amnion (*S* and *A*, figs. 51 and 52).

A slightly older embryo is shown in figure 39, in lateral view, and in figure 40, straightened out, in ventral view. The body is stouter, somewhat fusiform, and it ssegmentation is well defined. The cephalic lobes are further subdivided, the paired lobes of the labrum being quite large, the antennal rudiments more elongate and cylindrical, and the mouth-parts more distinct, especially the first maxillae. The legs, *LG*, and the pleuropods, *IA*, of the first abdominal segment are conspicuous enough, though the remaining abdominal appendages are decidedly obscure. The caudal end of the abdomen is bilobed. The embryo is bent backwards nearly into a circle. Cross sections of this stage (figs. 47 and 48) show much advance over that represented in figure 46. The sides of the body are well reflexed and the

neural groove, *G*, is quite deep, or nearly closed. The lower layer, *M*, has proliferated so as to constitute almost the entire dorsal portion of the embryo. Development has, as usual, progressed more rapidly at the anterior than at the posterior end (compare figs. 47 and 48). Figure 48, a cross section through the thoracic region, shows several large cells, *NB*, lodged in the ectoderm, on either side of the median line. These are the neuroblasts which are just beginning to give rise to ganglionic cells. They are not nearly so symmetrically arranged as are those of the orthopteron Xiphidium, studied by Wheeler ('90). A dividing cell, which protrudes from the ventral side of the embryo, strongly suggests the beginning of an appendage (*X*, fig. 48). By a process of splitting, the mesoderm, *M*, has given rise to the primitive coelom, *IC*. Its ventral are thicker than its dorsal walls. More posteriorly (fig. 47), neither the neuroblasts nor the primitive coelom are as yet discernible.

A stage intermediate between those of figures 39 and 41, is shown in cross section in figure 49 (abdomen). The sides of the body are further reflexed, the ganglia are marked swellings and contain a large number of ganglion cells which are lodged in a paler fibrillar matrix. The legs, *LG*, are not yet invaded to their extremities by mesodermal elements. The primitive coelom, *IC*, is no longer slit-like and appears in horizontal section as a pair of lateral sacs in each segment. Such sacs were found in the mandibular and all the following somites. The permanent body cavity or schizocoele (*C*, figs. 49, 50 and 51), is formed partly by the withdrawal of the inner walls of the coelomic sacs from the yolk-mass, and partly by the breaking down of the walls of these sacs. In the schizocoele are a few large free cells, with vacuolated protoplasm and large nuclei. These are probably haemocytes, *H*, which seem to have become separated from the inner, upper wall of the coelomic sacs, the splanchnic mesoderm, which early breaks down at this point. Just dorsal to the ganglionic swelling are several large pericardial cells, *PC*, which stain more deeply yellow. Like the haemocytes, they appear to be derived from the splanchnic mesoderm.

Figure 52 is a sagittal section of a more advanced embryo, such as is illustrated in figure 41. The yolk-mass is being

rapidly absorbed, and, with the exception of a comparatively small area at the cephalic end, is interposed between the amnion and the serosa. The central yolk-mass, *Y*, is becoming enveloped by a thin entodermal sheet *ENT*. The latter encloses a muscular layer on the ventral side of the yolk. The stomodaeum and the proctodaeum (*ST* and *PR*, fig. 52), are thick-walled tubes of columnar cells which are bounded externally by a muscular layer. A shelf-like extension near the inner end of the proctodaeum evidently represents a valve. A thin sheet of entoderm shuts off these two invaginations from the forming midgut. The ectoderm, in general quite thick, thins out intersegmentally and where it passes over into the amnion. The pleuropodia, *IP*, have reached their full size, and have evidently discharged most of the secretion. The central nervous system is compact and proportionally of great size so that the connectives are very short. The punktsubstanz or central fibrous material, *F*, occupies the more dorsal inner part of the chain and is enveloped by ectodermal epithelium, the inner neurilemma *IN*, (innere Nervenscheide, neuroglia), while the chain itself is ensheathed by a thinner though more distinct layer, the outer neurilemma or perineurium *ON*, also probably ectodermal. Both of these envelopes are figured by Graber ('89) in Stenobothrus, and by Wheeler ('89) in Doryphora. The remainder of the body cavity is to a great extent, occupied by irregular sheets of fairly well differentiated adipose tissue, by blood-cells, and by the large rounded yellow pericardial cells. The gonads, *GN*, a compact group of large cells, lie in the dorsal part of the fourth abdominal segment. What I take to be the 'suboesophageal body' of Wheeler is represented by a conspicuous bunch of large yellowish cells, *SG*, which partly invests the posterior end of the stomodaeum, on the ventral side. Except for the more vacuolated and granular contents, these cells, closely resemble the pericardial cells. Of the suboesophageal body, Wheeler ('92) says in part:

> It is apparently the earliest organ to be differentiated from the walls of the coelomic sacs. Its cells, at first wedge-shaped, gradually increase in size, become rounded and highly vacuolated and resemble the fat-

body elements, from which they may, nevertheless always be distinguished by their peculiar yellow tint. I have traced the organ which is a definite circumscribed structure, and which I call for the present, the suboesophageal body, through the embryo into the larva, where it disintegrates and finally disappears. I regard it therefore as a truly embryonic and early larval structure, quite distinct, at least physiologically, from the fat body. Its function is very doubtful.

He suggests that it may be nephridial. Both the pericardial cells and the suboesophageal body are formed before the fat-body is well differentiated. The pericardial cells are now the largest cells in the body.

Figure 51 is a cross section through the abdomen of an embryo of about the same age as that illustrated in sagittal section. The ectoderm is quite thick except over the median portion of the ganglion. On each side, closely appressed to the ventral ectoderm is a subspherical mass of pale cells, the oenocytes, *OE*. These have been shown by Wheeler ('92) to be of ectodermal origin. At least six such segmental clusters were found in the abdomen of the Photuris embryo. The hypodermis is somewhat thinner where the oenocytes are applied, as if they had been detached at the expense of this epithelium. The oenocytes, compactly massed, with the cell boundaries indistinct, the nuclei dark and reticulated, and the cytoplasm pale and vacuolated, little resemble the large free oenocytes of later life, where, with the exception of the eggs, they become the largest cells of the body. However, they do not surpass the pericardial cells for some time. They become spherical, migrate to the interior with the invaginating tracheae and mingle with some large reticulated fat cells. Oenocytes also occur in the adult beetle where they are often wedged in between the fat-body and have of course lost their segmental arrangement. The gonads, *GN*, are a compact group of large cells lodged in the splanchnic mesoderm, above and lateral of the paler fat-masses, *FB*.

The large arcuate embryo (fig. 41) must reverse its position, i.e., become coiled. The amnion is ruptured in this process. Figures 43 and 44 represent a Photinus embryo, which has become very stout and broad, undergoing this involution. The operation begins at the anterior end, as the caudal portion is

seen to be almost in its original arcuate position. The yolk-mass is becoming constantly smaller in proportion to the size of the embryo.

A Photuris embryo almost ready to hatch is shown in figure 45, lying in the final curled position. It now measures about 600 micra in the diameter of its curled position. Several days before emergence it is capable of slow movement, which is plainly visible, for the luminous organ, now functional, will be found to change its position.

The fate of the embryonic envelopes was not determined, no dorsal tube (the remnants of the serosa) was found, though it is probable that both the amnion and the serosa are eventually absorbed into the dorsal part of the body.

The mesenteron or midgut is much distended with the greater part of the deeply-staining yolk material, so that the freshly-hatched larva begins life with a full stomach.

THE PLEUROPODS OR FIRST ABDOMINAL APPENDAGES IN THE EMBRYOS OF PHOTURIS AND PHOTINUS

In both Photuris and Photinus, the pleuropods, so named by Wheeler ('90) are very conspicuous by reason of their size and structure. In neither genus was the organ observed in the first stages of development. In a Photuris embryo about one-third developed and before the enveloping amnion has been ruptured (fig. 39), the appendage, *IA*, is a knob-liked process with a sort, stout peduncle, and, like the thoracic legs, with its axis somewhat inclined caudally. It is a little less in diameter than the length of the segment from which it originates. In a sagittal section through the organ, its cells, which are of course hypodermal, are in large measure, strongly differentiated in that they are columnar, with larger, very elongate nuclei, three or more times as long as wide, the whole forming a somewhat convex layer or disc (fig. 54). At the distal extremity of the pleuropod there is already much granular secretion, which is evidently extra cellular and held in situ by the thin enveloping membrane, *C*.

A somewhat later embryo (fig. 41) shows the organ *IA*, considerably enlarged, its disc broader and flatter and the neck

proportionally shorter. The cells are four to six times as long as wide and form a flat disc. The nuclei occupy an approximately central position in the cells which may already be vacuolated just below the nuclei, but elsewhere well filled with a granular secretion which largely obscures the cell boundaries. The thin capping membrane is here frequently separated from the apices of the cells. Fat cells largely occupy the base of the peduncle.

A later stage, such as occurs in larvae nearly ready to hatch (figs. 45 and 55), shows that the gland has already largely performed its function. The cap *C*, may be depressed, irregular or wavy, the gland cells, *G*, now well below and separated from the cap, form a concave disc or crater, and seem almost to have exhausted the secretion, for very little of it is in evidence. The now spherical or subspherical nuclei, of the same height in each cell, strongly augment the crater-like appearance of the layer. Each cell has the walls closely applied to those of its neighbors, but the dividing line, *B*, between is usually discernible. Extending from just above the nucleus is the large conspicuous gland duct, *D*, flaring somewhat distally and often saccate at the base, so that the whole glandular structure, distally, has a papillose aspect. The basal portion of each cell, i.e., immediately below the nucleus, is marked by a large space or vacuole, *V*, beyond which are smaller indefinite vacuoles and protoplasmic strands. No muscle was found to connect with the organ, and in but one case what seemed to be a duct, leading from the distal portion of the gland into the body cavity, could be made out. The unmodified hypodermis, *H*, extends well up the sides of the cup where it passes off rather abruptly into the outer gland-cells. Viewed from above, the tips of the gland-cells form a network, the ducts constituting the circular or subangular spaces, the meshes, the cell walls.

It is quite evident that these large gland-cells are hypodermal and modified by elongation, etc. and from the jointed appendage, which, at first bilaterally symmetrical, becomes perfectly radial and extends somewhat pleurally of the thoracic appendages.

A larva quite near hatching shows the gland in the process of collapsing and of sinking into the body cavity. A freshly hatched larva, i.e., one a day old, has already lost the first abdominal appendages, remnants of which can be found in the body cavity. (According to Patten the pleuropods in Acillus are absorbed, while in the June-beetle, Melolontha vulgaris, they are probably pushed off (Graber). In other cases they seem to be in part cast off and in part absorbed). The gland-cell nuclei are now clearer, show scattered large pieces of chromatin; the cells themselves are breaking down, and the whole is forming a rather deep U-shaped mass. Large phagocytes occur in the vicinity; the cuticle and unmodified hypodermal cells are present above the organ, so that it is probable that they have spread over and covered the void made by the retracted gland-cells.

The pleuropod of Photinus is somewhat different morphologically from that of Photuris. It is more convex and elongate, the cells form a convex instead of a later, flat disc, their nuclei are distal, and correlated with this is the apparently internal basal secretion instead of the largely distal one as occurs in the pleuropod of Photuris. A conspicuous receptacle of non-glandular cells, *E*, calling to mind the cup of an acorn, surrounds and constitutes the basal portion of the pleuropod.

The remaining abdominal segments in either genus bear very small and inconspicuous appendages.

Korschelt ('12) describes and figures in several stages, the pleuropodia of *Dytiscus marginalis*. Evidently their development and their degeneration much resemble that in Photuris, in that they at first bear some resemblance to a thoracic leg, later become somewhat mushroom-shaped, with longer nuclei and a glandular character, and finally cave in and sink into the body shortly before eclosion. Korschelt refers to the pleuropodia as 'Drüsenorgane.'

The pleuropods were first noticed by Rathke, in 1844, in the mole cricket, Gryllotalpa. They do not appear to be of general occurrence among hexapod embryos. They are here (as in the Orthoptera and some Hemiptera) much larger than the following abdominal appendages. Many transitional forms occur. In

the Lepidoptera and Hymenoptera, according to Korschelt and Heider ('99) the limb rudiments of the first abdominal segments are, in some cases less developed than those of the other segments, and in no case do they attain a greater development. According to Graber, they are most leg-like in Mantis and developed into very large vascular sacs in Melolontha. In other cases they are mushroom-shaped, stalked cups, or they may be sunk below the surface of the body, i.e., invaginated (Hemiptera). (Dr. Wheeler thinks that the immersed condition of the hemipterous pleuropodia represents a late stage where such a condition is to be expected.)

The pleuropodia have been regarded as transitory respiratory, sensory, supporting, and glandular structures. The last view though indefinite, appears the most logical, since in most instances they are distinctly glandular in character. Wheeler thinks that the pleuropodia in ancestral insects may have functioned as odoriferous glands. Since they are so well developed in many cases, it is reasonable to suppose that they must be of some importance. In Photuris and Photinus embryos, stained in toto with borax carmine, the pleuropodia took the stain more deeply than the general body wall and more conspicuously than the other appendages, thus showing the more permeable character of their membrane.

SUMMARY

1. The two species of fireflies, Photinus consanguineus and Photuris pennsylvanica, differ in habitat, manner of flying and of scintillating, as well as in the color of the light emitted. The males and the females each scintillate in their own peculiar manner.

2. Both species require two seasons to complete their metamorphosis, the larval life occupying the far greater part of this time. They hibernate under stones and in the soil as young and as nearly full-grown larvae. The uniformity of a brood may be broken by the varying rate of growth of the individuals.

3. The eggs of both species are subspherical, and at first sticky, and are laid among roots or just under the soil. In the labora-

tory they hatch in less than three weeks. They are faintly luminous.

4. The larva of Photinus is subcylindrical and slender, that of Photuris broad and flattened-fusiform. Both are carnivorous and nocturnal. They feed also after the second hibernation and transform into pupae in May or June.

5. The pupae retain the two larval lights on the eighth abdominal segment, and in addition, the pupa of Photuris has a diffuse glow, especially in the head and thorax. The pupal period probably does not exceed twenty days.

6. Both sexes of Photuris are active flyers and runners. The female has a voracious appetite. Only the male of Photinus is an active flyer.

7. The photogenic organs of all Lampyridae thus far studied are formed on the same general plan. Each organ consists of an upper or reflector layer, and a lower or photogenic layer of cells. Tracheae and nerves penetrate both layers but are more highly developed in the lower. The cuticle which overlies the photogenic organs is usually translaucent.

8. There are in general two views on the derivation of the photogenic organs in Lampyridae, the one holds that they are derived from the hypodermis, and the other that they come from the fat-body. The latter view is the correct one, as Vogel ('13), and I have shown.

9. The development of the adult photogenic organ was studied in Photinus consanguineus. Here it is first seen in larvae near pupation. It is derived directly from the fat-body by the expulsion of its cells, which migrate to the ventral hypodermis. This cell-expulsion is effected or aided by the inflection of an investment which partly envelopes the fat-spheres here as also especially in the thoracic region. Numerous haemocytes apply themselves to these investments. No cell division was noticed during this process.

10. The cells thus liberated from the fat-spheres to form the photogenic organ, accumulate as an indefinite mass on the hypodermis and there proliferate. Two layers are gradually formed. During this process, the large albuminous granules common to

the fat-body, disappear in the forming light-organ. The reflector layer forms a sort of pavement epithelium of smaller, more clearly defined cells, while the photogenic layer is made up of larger, more rounded cells with more obscure limits. Small urate crystals occur in the upper, while minute photogenic granules darken the lower layer.

11. Tracheae and nerves enter both layers. In the photogenic layer, tracheal end-cells are developed. These end-cells are penetrated by nerves. The tracheal end-cells have slender capillary processes which seem to be intercellular and frequently anastomose.

12. The photogenic organs of the larva develop as evident structures, in late embryos. They are derived from neighboring fat cells, by migration and proliferation. As in the adult, the organ differentiates into two layers but the development is more obscure. The larval light-organ does not function in the adult. It appears to be a more primitive and less highly modified structure than the adult organ, and to be independent of the latter. In some species, as Ellychnia (infrequently), and Lampyris, it may grow in the adult.

13. The physiology of the photogenic organs has been much studied. The general belief is that photogeny is a process of oxidation of the photogenic granules, the oxygen being furnished by the tracheal end-cells. The process is dependent upon the nervous system, but photogeny may also be effected by local stimulation. Dried organs may be made to shine upon contact with water.

14. The photogenic granules are not fat-like but are probably an albuminoid which is insoluble in water and in fat-solvents. They have been regarded by some as luminous symbiotic bacteria.

15. The function of the larval photogenic organs is uncertain, but in the adult their purpose is to bring the two sexes together.

16. The germ-band of the embryo is of the immersed type, i.e., with yolk interposed between the amnion and the serosa. The amniotic cavity is formed before gastrulation occurs.

17. The embryo is at first almond-shaped, later the cephalic lobes appear and it becomes more and more arcuate. Finally the embryonic envelopes are ruptured, and the embryo reverses its position, assuming a coiled one.

18. The labrum is at first bilobed. The pleuropodia or first abdominal appendages are hypodermal structures, at first leg-like, but later glandular and mushroom-shaped. They finally disappear in old embryos by sinking into the body. Their function is uncertain.

19. The nervous system develops early. The neuroblasts are not very regularly arranged. An outer and an inner neurilemma is developed.

20. The stomodaeum and proctodaeum are deep, thick-walled invaginations. The midgut ultimately envelopes almost all the yolk material.

21. The primitive coelomic sacs are conspicuous, at first slit-like they later become rounded. They are shut off in each segment.

22. The pericardial cells appear to be mesodermal. They are of large size and differentiated even before the fat cells.

23. A suboesophageal body is present.

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PLATES

PLATE 1

EXPLANATION OF FIGURES

1 Photinus consanguineus larva, first instar.

2 Photinus consanguineus larva, full-grown.

3 Photinus consanguineus pupa, lateral view.

4 Photinus consanguineus adult, male.

5 Photinus consanguineus male and female, ventral view of abdomen. The shaded area represents the photogenic organ. *LO*, remnant of larval photogenic organ.

6 Ellychnia corrusca, egg showing oil-globules at surface.

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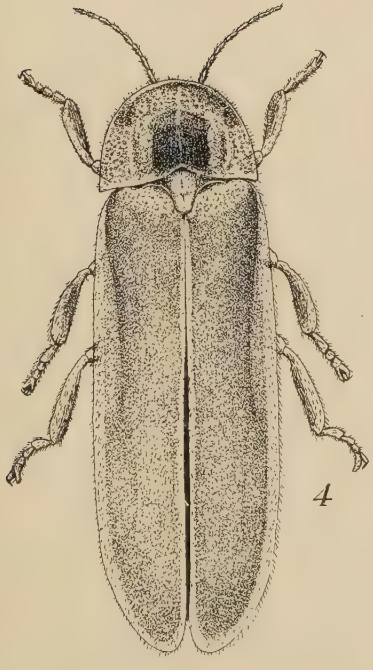

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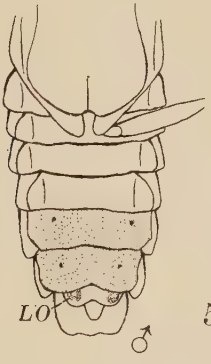

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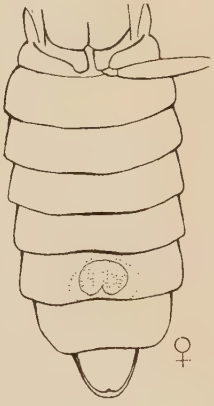

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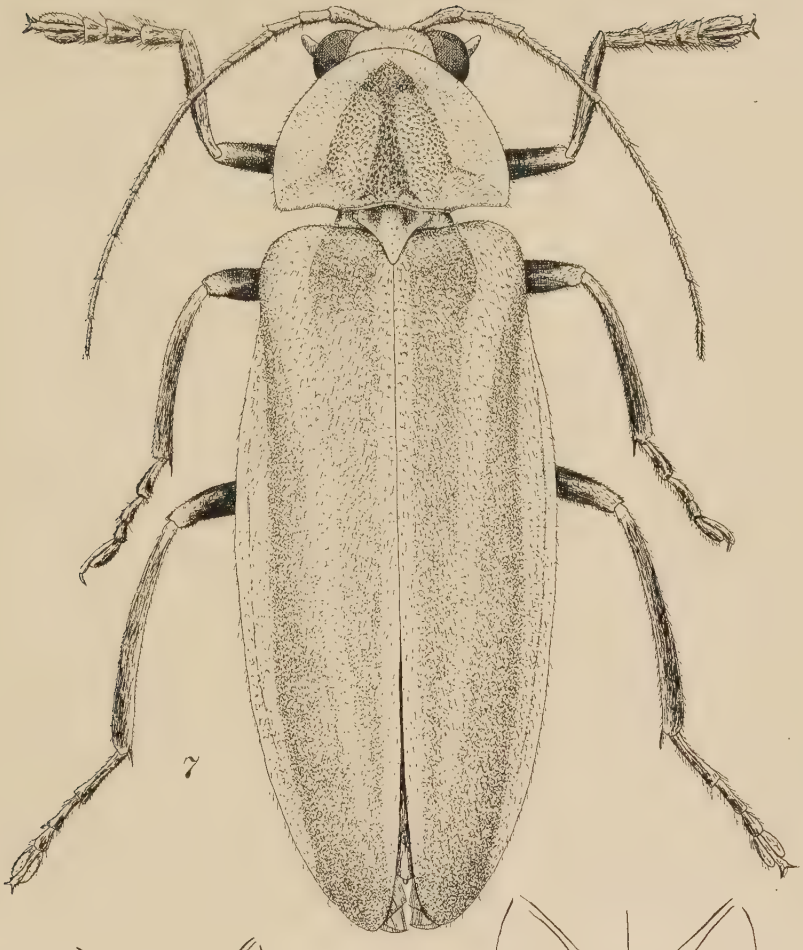
PLATE 2

EXPLANATION OF FIGURES

7 Photuris pennsylvanica, female.

8 Photuris pennsylvanica, male and female, ventral view of abdomen. The shaded area represents the photogenic organ.



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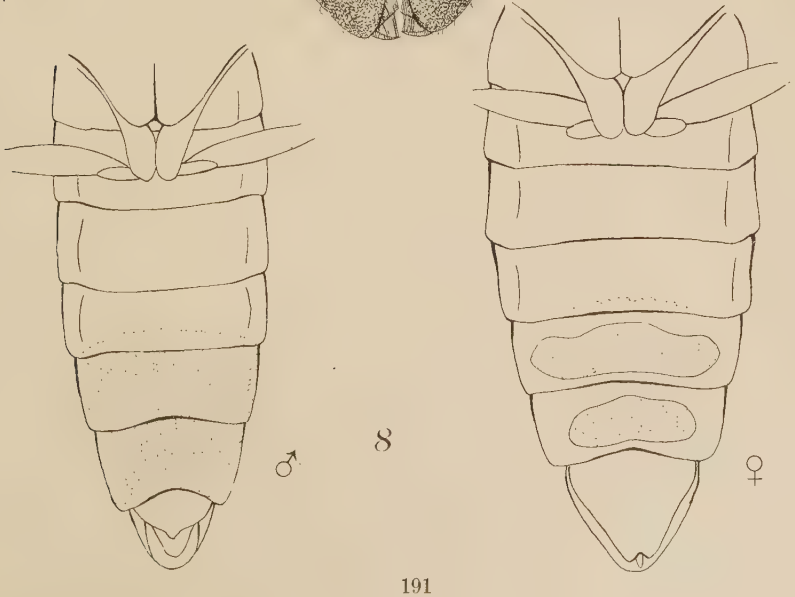

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PLATE 3

EXPLANATION OF FIGURES

9 Photuris pennsylvanica larva, first instar.

10 Photuris pennsylvanica larva, full-grown.

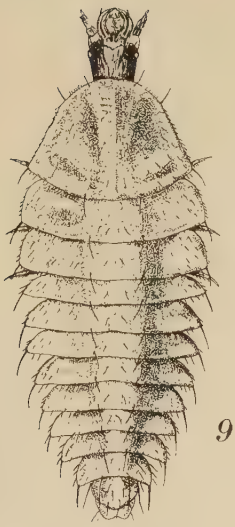
11 Photuris pennsylvanica pupa, ventral view.

12 Photuris pennsylvanica larva, full-grown, ventral view. *P*, photogenic organ; *S*, spiracle.

13 Cross section of photogenic organ of full-grown larva of Photinus consanguineus. *B*, blood cell; *C*, cuticula; *H*, hypodermis; *M*, muscle; *N*, nerve; *P*, luminous layer; *T*, trachea; *U*, urate or reflector layer.

14 Sagittal section of photogenic organ of embryo Photuris pennsylvanica. *A*, fat cell; *H*, hypodermis; *M*, muscle; *P*, luminous layer; *T*, trachea; *U*, urate or reflector layer.

15 Sagittal section of photogenic organ of embryo Photuris pennsylvanica, an earlier stage of development than in figure 14, *A*, fat cell; *H*, hypodermis; *M*, muscle; *O*, light-organ; *T*, trachea.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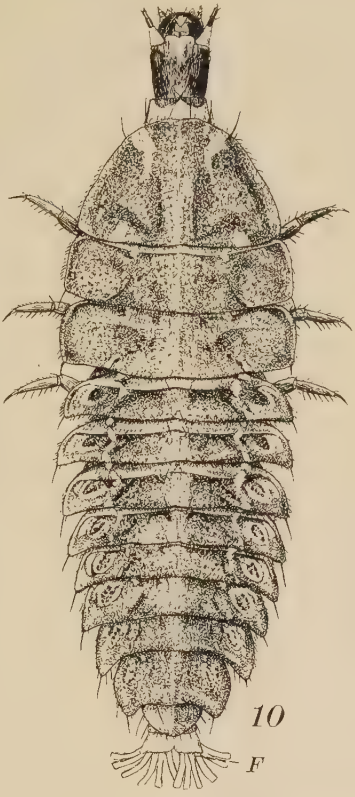

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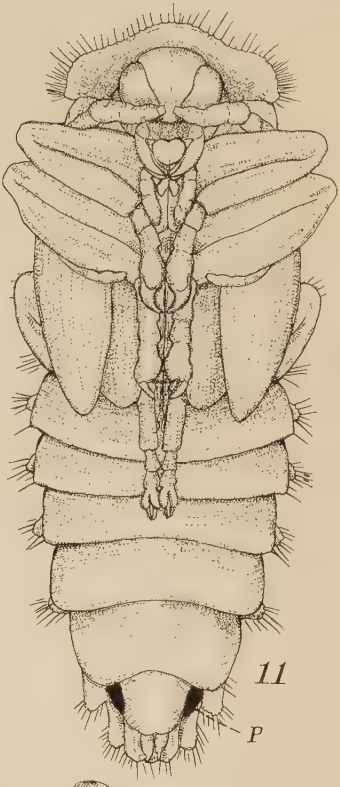

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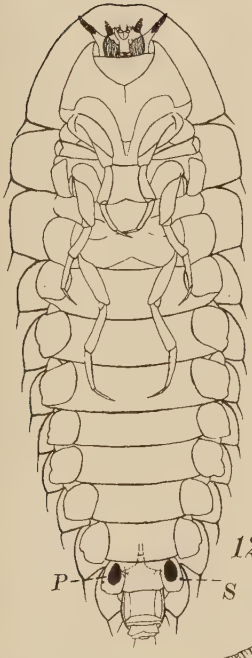

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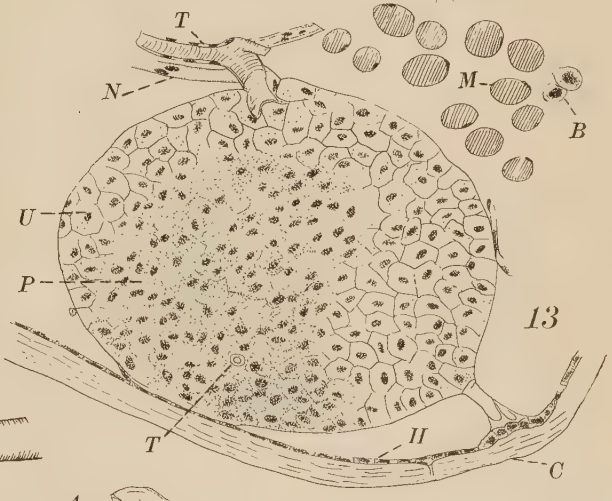

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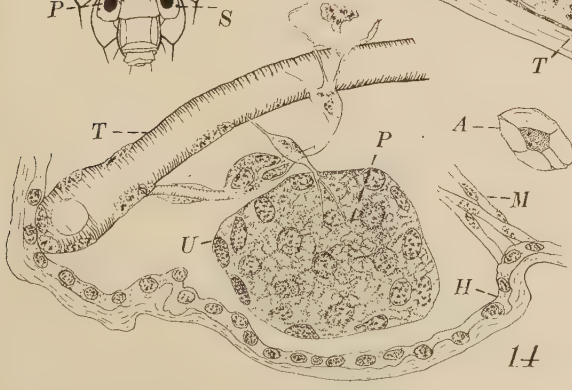

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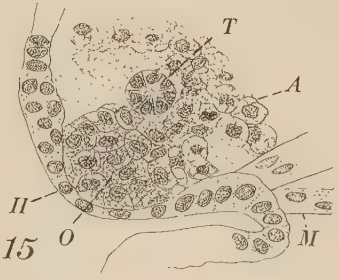

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PLATE 4

EXPLANATION OF FIGURES

16 Photogenic organ of full-grown larva of Photuris pennsylvanica, ventral view. *N*, nerve; *P*, luminous layer; *U*, urate layer.

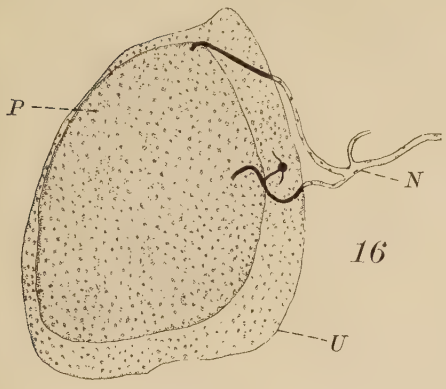
17 Section through a fat sphere of pupating larva of Photinus consanguineus. *FB*, fat haemocyte; *I*, cap or investment; *K*, nucleus of fat cell; *R*, rupture; *SB*, segmental haemocyte.

18 Section through fat sphere at a later stage than preceding; the investment *I*, is thicker and more constricted and the fat haemocytes *FB*, far more numerous.

19 Section through remnants of fat spheres and investments; lettering as in figure 17.

20 Fat and blood cells in Photinus consanguineus, one day out of the egg. *A*, fat cell; *B*, blood cell.

21 Fat cells in Photinus consanguineus, sixteen days out of the egg.



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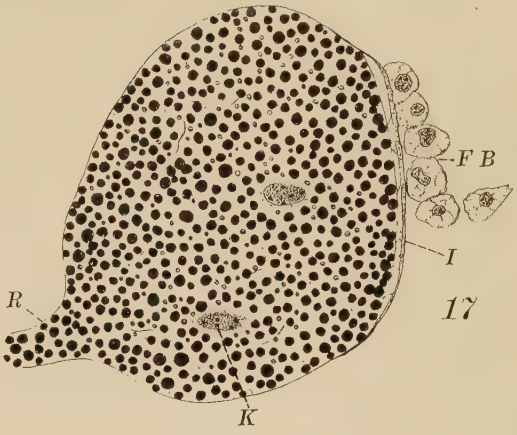

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PLATE 5

EXPLANATION OF FIGURES

22 Tracheal capillary penetrating the larval photogenic organ of Photinus consanguineus. *c*, capillary; *T*, trachea.

23 Tracheal end-cell penetrating the photogenic layer of the adult Photinus consanguineus; partly from Lund. *c*, capillary; *EC*, end-cell; *T*, trachea.

24 Earliest stage observed in the formation of the adult photogenic organ of Photinus consanguineus; sagittal section. *A*, photogenic fat sphere, *C*, cuticula; *FB*, fat haemocytes; *H*, hypodermis; *I*, investment; *P*, photogenic cells issuing from fat-sphere; *SB*, segmental blood cells; *T*, trachea.

25 Second stage in the development of the adult photogenic organ of Photinus consanguineus, lettering as in figure 24; cross section; here a number of the photogenic cells have migrated to the hypodermis.

26 Cross section through the region of the photogenic organ of an early pupa of Photinus consanguineus, at a later stage of development than figured in 25. *A*, fat-sphere; *C*, cuticula; *D*, dorsal vessel; *H*, hypodermis; *I*, intestine; *K*, Malpighian Tubule; *M*, muscle; *N*, nervous system; *O*, oenocyte; *P*, forming photogenic organ; *T*, trachea; *V*, vas deferens.

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PLATE 6

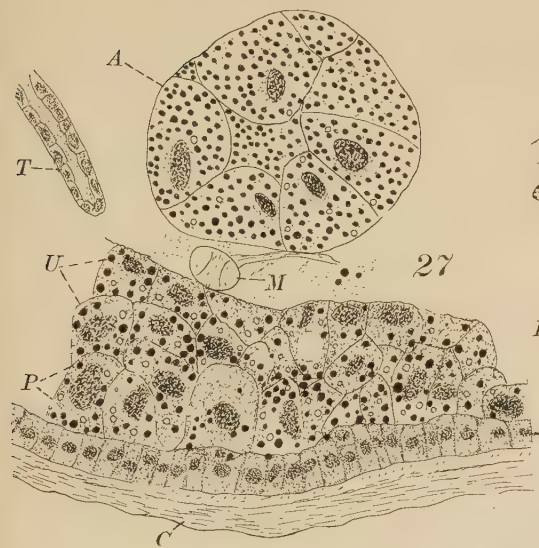
EXPLANATION OF FIGURES

27 Third stage in the development of the adult photogenic organ of Photinus consanguineus; cross section. *A*, photogenic fat-spheres; *C*, cuticula; *H*, hypodermis; *M*, muscle; *P*, luminous layer; *T*, trachea; *U*, urate layer.

28 Fourth stage in the development of the adult photogenic organ of Photinus consanguineus; cross section. *A*, fat tissue; *C*, cuticula; *E*, thickened tracheal epithelium of photogenic layer, where the end-cells are formed; *FB*, fat haemocytes; *H*, hypodermis; *P*, luminous layer; *T*, tracheal epithelium; *U*, urate layer.

29 Fully developed adult photogenic organ of Photinus consanguineus, in adult insect; cross section. *C*, cuticula, *c*, capillaries of tracheal end-cells; *H*, hypodermis; *P*, luminous layer; *T*, trachea; *U*, urate layer.

30 Disintegrating photogenic organ of adult Ellychnia corrusca. *A*, fat-sphere; *C*, cuticula; *H*, hypodermis; *M*, muscle; *P*, luminous layer; *T*, trachea; *U*, urate layer.



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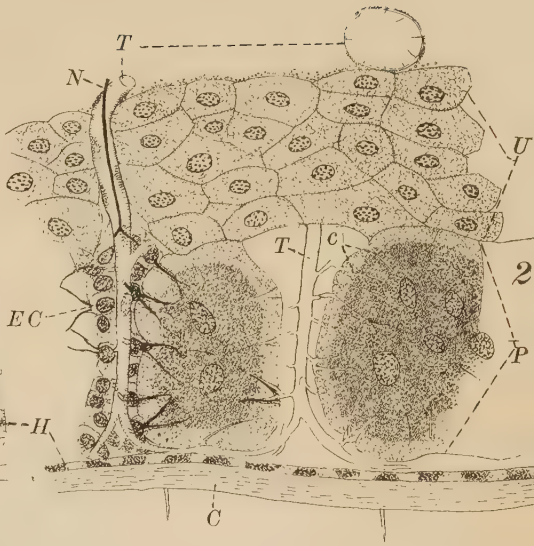

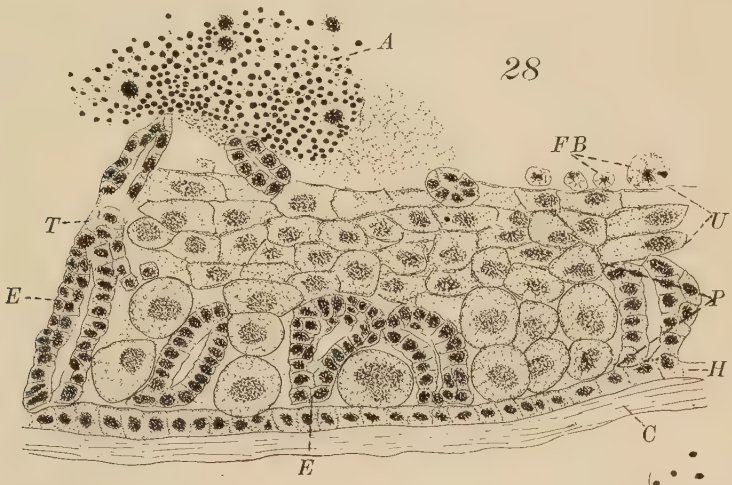

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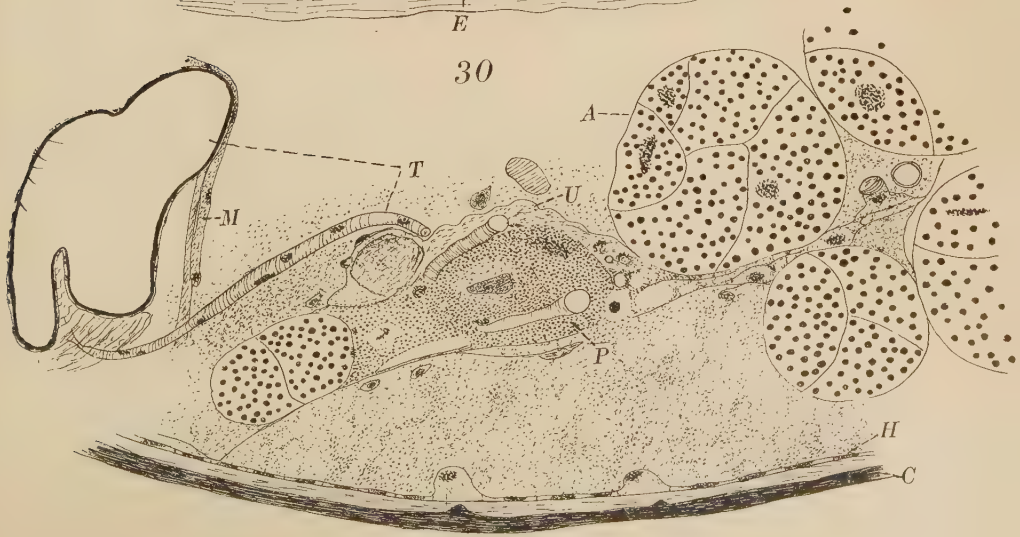


PLATE 7

EXPLANATION OF FIGURES

Embryology of Photuris pennsylvanica

31 Egg; yolk bodies represented by polygonal areas.

32 Section through egg; chorion not represented. *B*, blastoderm cells; *V*, vitellophags. The yolk pervades the entire egg.

33 Egg; divested of chorion; cross section. *A*, amnion; *B*, serosa; *G*, germband; *Y*, yolk.

34 Embryo of the same age as in figure 33; dorsal view; the broader end is the anterior one; the diamond-shaped area represents the place of union of the amnion and serosa.

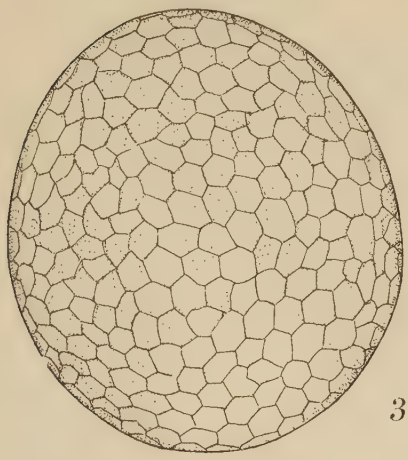
35 Slightly later embryo than figure 34. *P*, cephalic lobe.

36 Lateral view of figure 35. *A*, amnion; *P*, cephalic lobes; *Y*, yolk.

37 Slightly later embryo than figure 35. *A*, amnion; *P*, cephalic lobes; *Y*, yolk.

38 Head of embryo in early segmentation; ventral view. *A*, amnion; *F*, antenna; *L*, lobe of labrum; *P*, cephalic lobe.

39 Embryo in later metamerization than in figure 38. *A*, amnion; *F*, antennæ; *IA*, pleuropod or first abdominal appendage; *L*, lobe of labrum; *LG*, legs; *LI*, labium; *M*, mandibles; *MX*, maxillæ; *P*, cephalic lobes; *Y*, yolk.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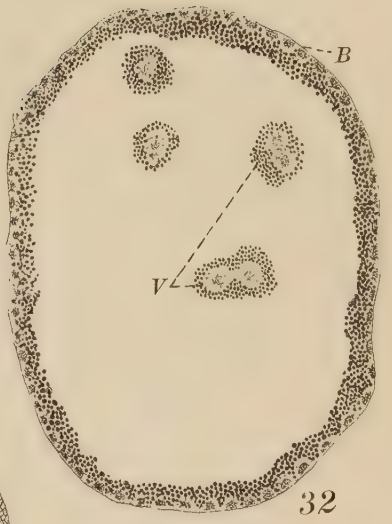

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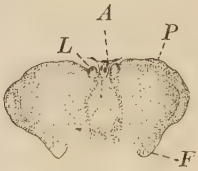

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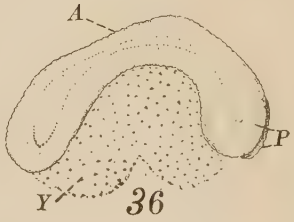

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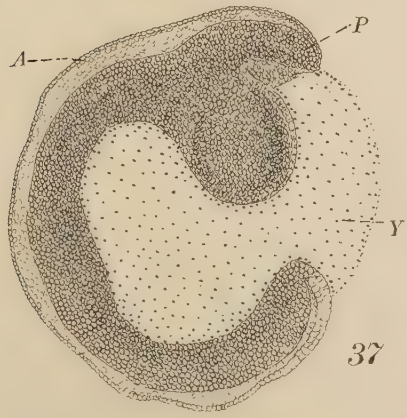

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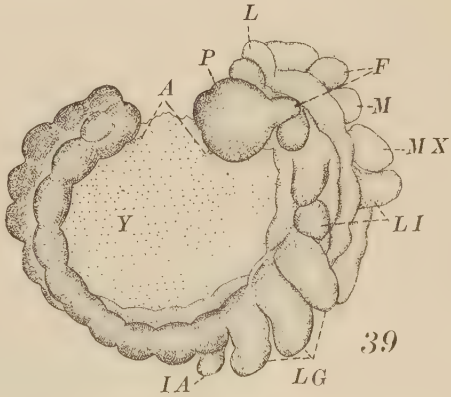

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PLATE 8

EXPLANATION OF FIGURES

40 Embryo of Photuris pennsylvanica, straightened out; ventral view, about same age as figure 39. *A*, amnion; *F*, antenna; *IA*, pleuropod; *L*, labrum; *LG*, legs; *LI*, labium; *M*, mandible; *MX*, maxilla; *P*, cephalic lobe; *U*, mouth.

41 Embryo of Photuris pennsylvanica, more advanced than figure 40; lateral view. Lettering as in figure 40; *Y*, yolk.

42 An early vitellophag.

43 Embryo of Photinus consanguineus; sublateral view. The embryo is commencing to curl up, beginning at the cephalic end; lettering as in preceding figures.

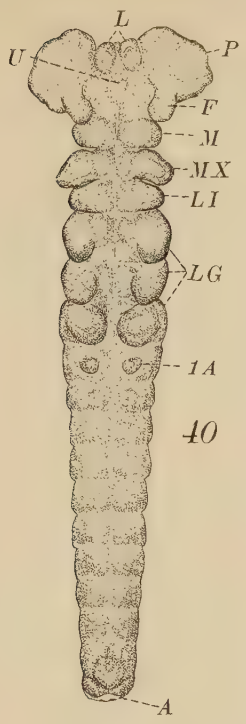
44 Same embryo as in figure 43, subventral view.

45 Embryo of Photuris pennsylvanica, nearly ready to hatch; lateral view. *IA*; pleuropod; *H*, head.

46 Cross section of Embryo of Photuris pennsylvanica, about the age of figure 37; head regions; *A*, amnion; *E*, ectoderm; *M*, mesoderm; *O*, amniotic cavity; *Y*, yolk.

47 Cross section of Photuris embryo of same age as figure 40; posterior end. *G*, neural groove.

48 Cross section of Photuris embryo of same age as figure 47; thoracic region. *A*, amnion; *IC*, primitive coelomic sac; *E*, ectoderm; *G*, neural groove; *M*, mesoderm; *Y*, yolk.



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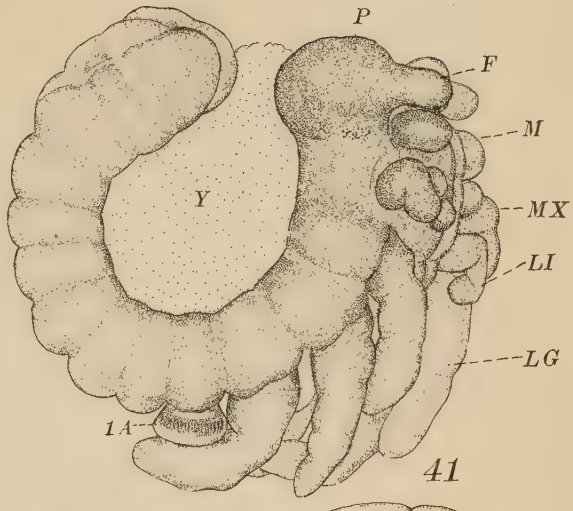

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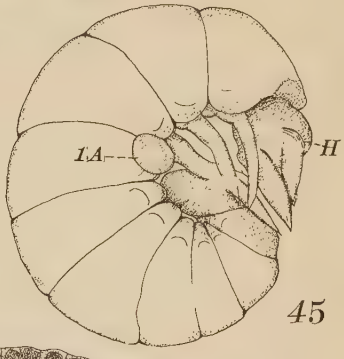

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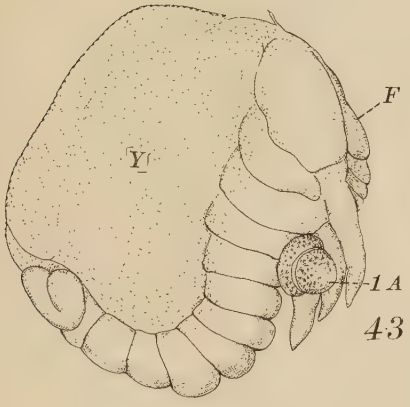

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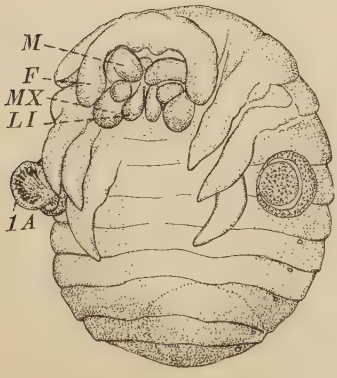

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PLATE 9

EXPLANATION OF FIGURES

Embryology of Photuris pennsylvanica

49 Cross section of an embryo at an age intermediate between figures 39 and 41; abdominal region. *A*, amnion; *C*, future body cavity; *IC*, primitive coelom; *Gr*, neural groove; *H*, haemocyte; *LG*, leg; *NB*, neuroblasts; *V*, vitellophag; *Y*, yolk.

50 Sagittal section through two coelomic sacs. *C*, future body cavity; *IC*, primitive coelom; *E*, ectoderm; *FB*, fat body; *H*, haemocyte; *M*, mesoderm; *OE*, oenocytes; *Y*, yolk.

51 Cross section of an embryo of about the same age as figure 41. *A*, amnion; *C*, future body cavity; *IC*, primitive coelom; *E*, ectoderm; *ENT* entoderm of midgut; *FB*, fatbody; *G*, ganglion; *GN*, gonad; *H*, haemocyte; *NB*, neuroblasts; *O*, amniotic cavity; *OE*, oenocytes; *PC*, pericardial cells; *S*, serosa; *Y*, yolk.

52 Sagittal section of an embryo of about the same age as figure 51. *A*, amnion; *IA*, pleuropod; *BR*, brain; *E*, ectoderm; *Ent*, entoderm; *F*, punktsubstanz; *GN*, gonad; *H*, haemocytes; *IN*, inner neurilemma; *O*, amniotic cavity; *ON*, outer neurilemma; *PR*, proctodaeum; *S*, serosa; *SG*, suboesophageal body; *St*, stomodaeum; *T*, trachea; *Y*, yolk.

LG
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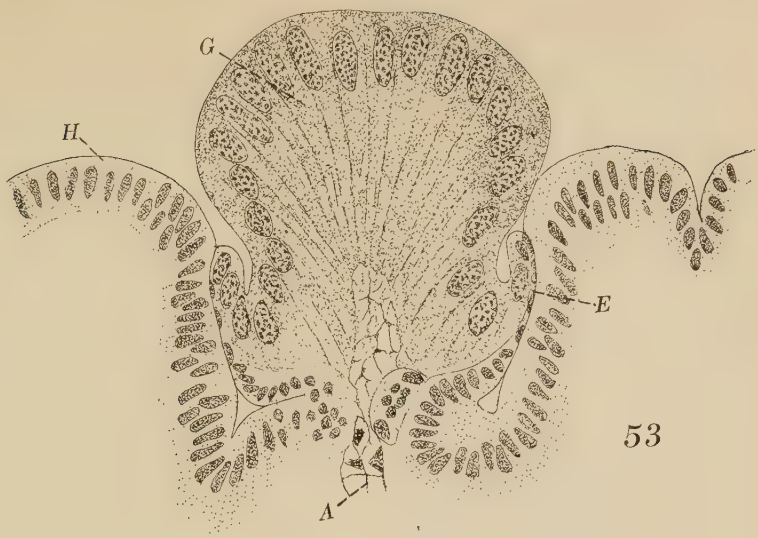
PLATE 10

EXPLANATION OF FIGURES

53 Pleuropodium of Photinus consanguineus; sagittal section. *A*, fat cells; *E*, basal cup; *H*, unmodified hypodermis; *G*, gland cells.

54 Pleuropodium of Photuris pennsylvanica; sagittal section. *A*, fat cells; *C*, cap; *H*, hypodermis; *G*, gland cells.

55 Pleuropodium of Photuris pennsylvanica, at a much later stage than figure 54. *A*, fat cells; *B*, boundary between two gland cells; *C*, cap; *D*, duct of a gland cell; *G*, gland cell; *H*, hypodermis; *V*, basal vacuole of gland cell.



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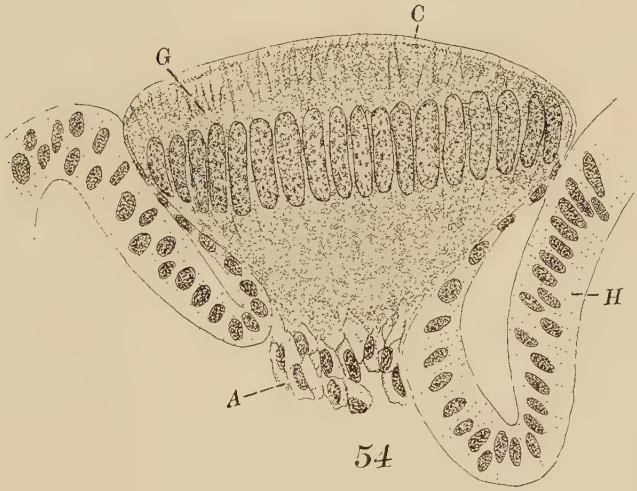

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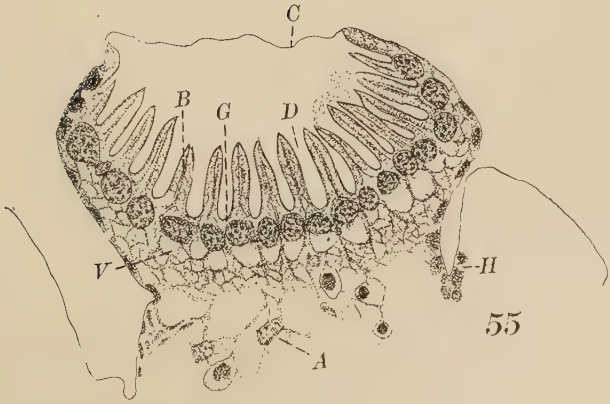

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THE JOURNAL OF MORPHOLOGY
VOLUME 28, NUMBER 1, DECEMBER 20, 1916

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BALTIMORE, U. S. A.

A NEW SPECIES OF THRIPOCTENUS
(Chalcidoidea)

By L. T. WILLIAMS

[Reprinted from Psyche, Vol. XXIII, No. 2]

A NEW SPECIES OF THRIPOCTENUS (Chalcidoidea).[1]

By L. T. Williams.

During an afternoon's collecting in a swampy spot near the Arnold Arboretum, Forest Hills, Mass., a few galls on willow twigs were secured and brought into the laboratory at the Bussey Institution. A casual examination on the date of their collection (July 22, 1915) showed that they contained immature insects of some sort, but no further attention was paid them until August 10, when the galls were opened and found to contain several large black thrips, and a single minute Chalcidoid parasite. Any possible doubt as to the relationship between the insects was removed when the parasite was identified by Professor Brues as belonging to the genus *Thripoctenus*, which is known to be an enemy of the Thysanoptera.

The genus *Thripoctenus* was proposed in 1911 by Crawford for a new species from California, belonging to the sub-family Tetrastichinæ, and described by him under the specific name of *russelli* in honor of its discoverer, the late Mr. H. M. Russell. A second species has recently been described in Europe by Vuillet. I have not had access to this description but the differences in habitat and in the systematic positions of the hosts would indicate that the present species is perfectly distinct. The characters distinguishing it from the type species are well marked, as will be noted later.

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 112.

The following description contains certain characters of generic, rather than specific value, which are included merely for convenience in identifying specimens.

Fig. 1. 1, Willow galls occupied by thrips; 2, Parasitized thrips containing three larvæ of *Thripoctenus nubilipennis*; 3, *Thripoctenus nubilipennis* ♀; 4, Antenna of same, ♂.

Thripoctenus nubilipennis sp. nov.

Female: Length, 0.7–0.9 mm. Antennæ inserted just above the clypeus, 7-jointed, the club of 3 segments and the funicle of 2, the latter shorter than the pedicel. Head as wide or slightly wider than the thorax, seen from in front distinctly wider than long. Clypeus with a distinct keel. Front broad, strongly concave. Inner eye-margin with a row of bristles, the posterior one long and conspicuous. Ocelli in a low triangle. Genæ prominent,

well-developed. Mesonotum convex, somewhat cordate, owing to a posterior cleft or indentation. Parapsidal furrows incomplete, indistinct during life. Scutellum oval, without longitudinal furrows. Tegulæ with a pair of bristles. Abdomen elongate-ovate, about as long as the thorax, laterally keeled or compressed. Ovipositor scarcely visible when at rest. Color, black, highly polished, tarsi, except for dusky terminal joints, testaceous. Antennæ dark, but translucent, hence appearing yellowish when mounted; clothed with whitish hairs. Eyes very dark russet-red, almost black; ovipositor yellow, transparent. Wings with a distinct median cloud, and a marginal thickening or pigmentation extending from the end of the post-marginal vein to a point on the posterior margin opposite the stigmal vein. Wing-cilia very long, dark-colored.

Male: Smaller (on the average) than the female, abdomen slenderer more abruptly tapering. Antennæ 7-jointed, as in female, but differing as follows: scape broader, pedicel shorter than the funicle, club much less marked. Joints of the flagellum with whorls of bristles. Terminal joint with a rod-like, bristle-tipped prolongation, about two-thirds as long as the joint. Color, as in female.

This species is very readily distinguished from *T. russelli* by its uniformly black color and clouded wings. The rod-like appendage of the male is very curious and distinctive, though it may pass for an ordinary bristle if not closely examined under a compound microscope. I presume that it is characteristic of the genus, though I have no means of knowing this, the male of *T. russelli* being as yet undescribed.

Habits of the Hosts.

Specimens of the thrips were sent for determination to Dr. J. D. Hood of the Biological Survey, who kindly identified them as belonging to two species, *Megalothrips spinosus* Hood and *Cryptothrips rectangularis* Hood, both members of the family Phlœothripidæ. Unfortunately, the larvæ of the two forms were not distinguished during the course of my observations, and it is impossible to ascertain at present whether their relations to the parasite are different, but it seems probable that either is attacked without discrimination.

After the parasite's relation to the Thysanoptera had been established the locality where the galls had been collected was re-visited, and large numbers of additional specimens secured from time to time. These galls were not, of course, the work of the thrips. They were practically all on dead wood, and may have been several seasons old. The commonest type, and that most frequented by the thrips was the one shown in Fig. 1, 1, but the insects were also found in other sorts, among them the well-known "pine-cone" willow gall. The original inhabitant of the gall is therefore of little importance, since the thrips evidently occupy any sort that will accommodate them.

The galls are not a mere temporary shelter, as all stages of the thrips from the egg to the adult were to be found in them, and none were found outside, upon the twigs. There seem to be no definite generations, all stages being obtainable at any time during the period for which they were under observation. What they eat, unless they are able to subsist on the dry wood of the gall, seems a mystery, the dead willows being the only visible source of nourishment. The other insects found in the galls are scarcely sufficient to permit of a regular carnivorous habit, although occasional cannibalism is not unlikely.

Habits of the Parasite.

The life-history of *Thripoctenus russelli* has been studied in detail by Mr. H. M. Russell of the Entomological Bureau. The writer has not been able to treat the present species so exhaustively within the time at his disposal, but the details gathered show many points of similarity between the two species as well as several interesting differences.

Oviposition: On the 16th of August no parasites had issued from the new lot of galls, and to hasten matters a number were cut open, several female parasites rewarding the search. Two or three of these were placed in a vial with an immature thrips. At first they ran around without paying any particular attention to it, but before very long one of them ran up, examined the thrips briefly with its antennæ, and then immediately thrust its abdomen forward between its legs and punctured the larva with its ovipositor. After a moment, however, it relinquished its attempt for no apparent reason. Later the same thrips was approached by a par-

asite (No. 1) which went through the preliminary motions of oviposition, but before it had completed the action another (No. 2) ran up and pierced the thrips with its ovipositor. After remaining in this position some minutes its applied its mouth to the puncture and sucked the wound for about the same length of time. Meanwhile No. 1 repeatedly brought its abdomen forward as if to oviposit, but failed to do so. Both insects immediately afterwards deposited something on the wall of the test tube, which may have been merely excrement, though in the case of No. 1 it was shaped very like the usual parasitic egg.

Subsequently, numbers of adults and pupæ of the *Thripoctenus* were obtained, and the process of oviposition was frequently witnessed. The thrips and parasites (one individual of each, as a rule) were placed on a glass side within a ring of paraffin, and covered with a cover-slip. Under these unnatural conditions the behavior of the parasites was somewhat capricious. Their first action was almost invariably a systematic examination of their prison, out of which, if there was the smallest space between the wax and the cover they usually succeeded in forcing their way. After these efforts had been brought to a conclusion they might or might not show some interest in the thrips. Often they remained with their antennæ applied to the bodies of the larvæ, without attempting to oviposit. Under such conditions any slight movement on the part of the thrips was likely to stimulate the parasites to action. If they met with the thrips at an unfavorable angle they seldom rectified their position, but let it go. The thrips also showed some variation in their receptions of the attack. They were generally rather quiescent, but sometimes crawled about rapidly in their endeavor to escape. This was usually successful, especially if done just as oviposition commenced, but occasionally a more persistent parasite followed its prey, sidling along to the best of its ability, and still holding on when dragged head-long, or circumvented its victim by mounting on its back. Sometimes the thrips, particularly the pupal forms, protected themselves by violently contorting the tips of their abdomen, and in one case one of them was seen to excrete a drop of brownish fluid on the wings of the Thripoctenus.

Oviposition, when successful, usually required ten or fifteen minutes, and a half-hour was not uncommon. After this there was

normally a rather long period of sucking the wound, followed occasionally by a second oviposition. This last, however, was seldom allowed to occur, as I desired to obtain as many parasitized thrips as possible, and usually replaced the infested individuals with fresh ones. There was no particular point selected for attack, though the abdomen was more often pierced than the thorax. In the length of time required for oviposition the species differs markedly from *T. russelli*, which is described as taking less than a minute for the process. The subsequent tasting of the wound appears also to be omitted by the latter species.

The number of larvæ which a parasite would attack was not definitely ascertained. After attacking three or four the female Thripoctenus usually died or made its escape. Those that had already oviposited could be counted upon for a repetition of the process more surely than those which had not so far attempted it.

All stages of the thrips except the adult are attacked, the newhatched larvæ with an alacrity which appears to be ill-judged, as the larvæ of the parasite can hardly develop in them properly, the pupæ with a reluctance which may be well-founded. At least one pupa transformed after a Thripoctenus had oviposited in it.

Development of the Larvæ: The lengths of the egg and larval stages of the parasite were not determined. It seemed impossible to keep the larval thrips alive after removal from the galls, and moreover, individuals oviposited in under laboratory conditions often proved to have been previously infested. The only method of avoiding this source of error was to raise the hosts from the egg, and this could not be managed. Only occasionally were parasite larvæ obtained by dissection. These were extremely delicate in the early stages. One well-grown specimen, dissected from a pupal thrips, resembled the mature forms, being quite smooth, very faintly segmented, and without any pigmentation in the head.

Parasitization was not obvious until it had reached an advanced stage. At this time the host larva grew mottled and waxy in color, the body was much swollen, and the insect was perfectly torpid, if not dead. In a day or two the outlines of the parasites showed beneath its skin. Owing to the large size of the host, successful multiple parasitism is possible, and indeed appears to be the rule. The plate shows a thrips containing three larvæ, and judg-

ing from the groups of pupæ found, even more may complete their development in a single host. This is impossible with the smaller hosts of *T. russelli.* The larvæ are always oriented in the same direction, their heads towards that of the thrips. The skin of the latter soon splits and shrivels to a small pad, to which the larvæ remain attached until they pupate. As in the case of *russelli* the contents of the alimentary canal are retained until after the insect has completed its transformation. This substance, bright crimson at first, loses its color shortly before the pupal stage, and is voided by the adult as a milky fluid.

In a few cases the length of the pupal stage was determined. Five larvæ developed from two thrips (three in one, and two in the other) began to darken on August 31. The first three were completely black by next day, the other two twenty-four hours later. On the 11th of September four of the five pupæ (all of the first lot and one of the other) hatched. Two were males and two females. The last pupa, a female, hatched on the 13th.

Adult: Perhaps the most striking difference between *nubipennis* and the Western species consists in the presence of males in the former. *Thripoctenus russelli* was found to be both parthenogenetic and thelytokous, no males being produced through all the generations that were reared. In *nubipennis* the male is not uncommon, though slightly rarer than the female. Copulation was observed on more than one occasion. It is a process of very brief duration.

The sex of the offspring of unfertilized females could not be determined, owing to the aforementioned difficulty in keeping the thrips alive.

The adults ran about actively but were not observed to fly, and seldom jumped. They did not feed when offered syrup, but the females were fairly well supplied with the juices of the thrips. Those that oviposited frequently survived the others, but four or five days was about the maximum length of life under laboratory conditions.

The presence of a member of this genus in the Eastern States is probably of no economic importance, since the thrips upon which it preys are not injurious. They belong to a different suborder from the hosts of the two species of Thripoctenus hitherto described. Whether or not *nubipennis* would attack members of

the Terebrantia could not be determined for lack of material, but the great difference in habit renders it unlikely that it would do so under natural conditions.

Acknowledgments.

My thanks are due Professor Brues for aid in classifying the parasites and for suggestions and references of all kinds during the course of the experiment. To Dr. Hood I am indebted not only for the determination of the hosts as mentioned above, but also for information about their life-history and for references on the parasite. Much use has been made of Mr. Russell's bulletin for purposes of comparison.

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[Reprinted from JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, Vol. XXIV, No. 2, June, 1916.]

NOTES ON SOME SLAVE-RAIDS OF THE WESTERN AMAZON ANT (POLYERGUS BREVICEPS EMERY).[1]

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While camping during the summer of 1915 at Fallen Leaf Lake near Lake Tahoe, in the Sierras of California, I had an opportunity to observe several slave-raids of the western amazon ant (*Polyergus rufescens* Latr. subsp. *breviceps* Emery), a form not hitherto known to occur in California. In my book on the ants[2] I described a few forays of this ant in Colorado, but the Californian colonies exhibited some peculiarities of behavior not heretofore observed in any of our North American amazons. Only five colonies were seen during ten days devoted to the study of the ants of the Lake Tahoe region, so that in this locality *P. breviceps* is evidently much rarer than in certain localities (*e. g.,* Florissant) at the same or greater elevations in the Rocky Mountains of Colorado. The slave in all the colonies was an ill-defined variety of *Formica fusca,* less pubescent than var. *subsericea* Say or *argentea* Wheeler and larger and less shining than the typical form of the species.

The notes taken on the following dates refer to as many different colonies:

[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 113.

[2] Ants, Their Structure, Development and Behavior. Columbia Univ. Press, 1910, p. 475–477.

July 22. At 4.30 P. M. a large army of *breviceps* workers was seen hastening along the rocky trail, at an altitude of about 6,000 ft., on the eastern slope of Mt. Tallac, about 50 feet above the surface of Fallen Leaf Lake. The ants were followed to a *fusca* nest which they had just reached. The *fusca* workers had retired into their galleries and could be seen hurriedly closing the small entrance from within with pellets of earth, evidently for the purpose of shutting the amazons out. The latter, however, at once tore out the barricade and poured into the nest. Soon they began to bring up the *fusca* pupæ and at once hurried back over the trail. I followed them to their own nest which was nearly 60 feet from the plundered colony, in the narrow crevices of some large rocks where it could not be examined. By 5.15 P. M. all the amazons had entered their nest. The supply of *fusca* brood secured on this raid was not considerable, since only about one in ten of the returning workers carried a pupa or larva in its jaws. Retracing my steps to the *fusca* nest, I found its inhabitants slowly and apparently with reluctance returning to it.

July 24. A small colony consisting of a wingless, ergatoid female and about a dozen small *breviceps* workers and nearly two dozen *fusca* workers was found under a log in a warm hollow at an altitude of nearly 7,000 ft. on the eastern slope of Angora Peak. This was evidently a young colony, with the ergatoid female functioning as its queen. This insect had the gaster considerably distended with eggs.

July 25. At 4.20 P. M. I encountered a small colony of *breviceps* returning from a raid on the Mt. Tallac trail near Fallen Leaf Lodge, not far from the spot where I observed the foray of July 22. I did not stop to locate the nest.

July 29. At 3.45 P. M. I came upon a large *breviceps* army returning to its nest laden with pupæ near Glen Alpine Springs at an altitude of about 7,000 ft. The nest was easily found under a large flat stone, which I lifted just before the returning army arrived. The nest-chembers were full of *fusca* workers and pupæ, but only two or three amazons had remained among them, and had not, therefore, taken part in the foray.

The notes taken on the following dates refer to a single *breviceps* colony which was observed on five consecutive days, not only by myself but also by many of my fellow campers and by Mr. Wm. W.

Price, the genial ornithologist and proprietor of Fallen Leaf Lodge:

July 26. At 4.10 P. M. I discovered the nest of a very large *breviceps* colony under a small flat stone near the mouth of the canyon through which the stream runs from Glen Alpine Springs to Fallen Leaf Lake. The army of several hundred workers was just emerging and congregating around the three nest orifices in preparation for a foray. The ants very soon hurried off in great excitement down the canyon to a *fusca* nest at least 70 feet distant. The trail was difficult, as the insects had to cross a very dusty road, climb over a pile of rough boulders, creep under a lot of low bushes and then traverse many feet of rocky soil. The first individuals, however, reached the *fusca* nest at 4.30 P. M. and at once entered it through several openings so small and so much obstructed with pellets of earth that I should not have found the nest without the guidance of the amazons. The *fusca* workers offered no resistance, but fled in all directions. A few managed to escape with larvæ in their jaws. The amazons poured into the nest entrances and soon emerged with the first pupæ, nearly all of which were naked (*i. e.,* not enclosed in cocoons) at 4.40 P. M. and at once started for home. The vanguard of the returning army, nearly every worker of which was carrying a pupa, reached the nest at 4.55 P. M. and the last stragglers had arrived by 5.10 P. M. The foray was therefore completed in an hour. It was accompanied by an unusual performance—a partial marriage flight. About 20 winged female amazons and a greater number of males left the nest with the army of workers and while some of the couples lingered behind and mated on the ground or low vegetation and several of the males flew away without mating with their sisters, several of the females accompanied the workers and even entered the *fusca* nest. None, however, was seen to return with the pupa-laden workers. A few, which had mated, tore off their wings and ran about over the ground. They probably returned to the nest after I had left the spot.

July 27. I visited the amazon nest at 3.35 P. M. and found that the army had just departed. It took a more northerly direction than on the preceding day, and after covering a distance of about 75 feet, stopped and began to hunt about among the stones and sparse vegetation. After several minutes devoted to this search, the greater portion of the army moved on but the remainder discovered a small

fusca nest, plundered it without opposition and at once returned home with all the pupæ that could be secured. The main army hurried on over a very rough, stony trail. They stopped twice, searched about diligently but in vain, and each time changed the direction of their route. Several completely or partially deälated females accompanied the main army the whole distance and seemed to be quite as keenly interested in the proceedings as the workers. The army halted a third time at a spot 125 feet distant from the point where the first nest was plundered and succeeded in discovering a flourishing *fusca* colony consisting of large workers. These were very aggressive and fully prepared to defend their nest, which, like all the *fusca* nests in the vicinity of the amazon colony, was very carefully concealed under and between stones. The amazons reached this nest at 4.30 P. M. and exhibited great excitement. Some of them attacked the *fusca* fiercely, while others kept digging their way into the earth-barricaded entrances. *Fusca* workers could be seen defending their doorways from within, but they were mercilessly dragged out and massacred in the usual manner, by having their heads pierced with the sickle-shaped mandibles of the amazons. Finally, after a struggle of fully 30 minutes, at 5 P. M. the first *fusca* pupæ were brought out. Their bearers turned at once in the direction of their nest, nearly 200 feet away and hurried towards it over a path, *which, for fully 40 feet, was entirely different from the one over which they had come.* A stream of pupa-laden amazons issued from each of two nest orifices and at once united to form a single file. Even the young callow *fusca* workers were dragged out by the antennæ and then seized by the thorax and carried along. Several of the deälated females returned with the workers but none was seen to carry a pupa. The army reached the home nest at 5.30 P. M., so that this foray, during which two *fusca* colonies had been thoroughly plundered, and fully 400 feet of ground had been traversed by most of the individuals, was completed in two hours.

July 28. The amazon army left the nest at 4.15 P. M., plundered a large *fusca* colony after traversing nearly 80 feet of rough, stony soil to the southeastward, and returned with many pupæ by 5.30 P. M. The army was accompanied both to and from the *fusca* nest by several deälated females, but none of them carried pupæ.

July 29. I arrived late at the amazon nest, but found Mr. Price

already there with several campers, all intently watching the ants. According to their statements, the army left the nest about 3 P. M. After going some 60 ft. it hesitated and part of it discovered a small *fusca* colony, plundered it and returned home at once with the booty, while about half of the army changed its direction and proceeded to a point about 80 feet from the home nest in a more northerly direction than any of the previous forays and along the bank of the stream. The ants soon succeeded in detecting a *fusca* colony, which, however, offered stubborn resistance. This was overcome and the robbers were all returning laden with pupæ when I reached the spot between 4.50 and 5 P. M. One of the observers saw a few winged amazon females in the outward-bound army, but none was seen returning to the nest.

July 30. The amazon nest was watched by Mr. Price, about twenty campers and myself from 2.30 to 4.30 P. M. but made no foray. This was very probably due to the weather, which was cloudy and much colder than on the preceding days. Nevertheless quite a number of males escaped from the nest, especially between 2.30 and 3.30 P. M. Some of them flew away, others almost immediately returned to the nest and several were violently dragged back into it by the *fusca* slaves. Only two dealated females left the nest. They ran about for some time and then returned into the entrances of their own accord. The slaves were very active at all three entrances and seemed to be constantly keeping the worker amazons from making a sortie. On lifting the stone covering the galleries several winged females were seen near one of the entrances, but none of them left the nest. The following morning I was compelled to leave Fallen Leaf Lodge and was therefore unable to continue my observations.

The following points are particularly interesting in these field observations in connection with those recorded in my ant book on the same subspecies in Colorado, *P. rufescens bicolor* in Illinois and *P. lucidus* in New York:

1. Although it is known that both the European and American amazons make their raids only during the afternoon, the sorties previously recorded for our American forms, though also observed during July, occurred at an earlier hour, as follows: *breviceps* at 1.55 P. M. *bicolor* before 2 P. M.; at 1.35 and 1.20 P. M.; *lucidus* at 2.20 P. M. One foray of *lucidus* observed by Burrill in Pennsylvania started be-

fore 2.30 P. M.[3] The four sorties of *breviceps* observed near Fallen Leaf Lake occurred at 4.10, 3.35, 4.15 and 3 P. M., and the three armies merely seen returning to the nest July 22, 25 and 29, could hardly have started out before 3 P. M. In this connection I may mention, also, that the two forays of the small shining *P. rufescens læviceps* Wheeler which I observed July 20, 1914, on the slopes of Mt. Tamalpais, near San Francisco, Calif., must have left their nests after 3 P. M. How are we to account for this difference in time of sortie between the Californian amazons and those of Colorado, Illinois, Pennsylvania and New York?

Before attempting to answer this question it will be advisable to glance at some of the published accounts of the typical European *P. rufescens*. The most comprehensive observations on this ant have been made by Forel in Switzerland.[4] During 33 days he saw a single *rufescens* colony make 44 expeditions and estimated that the ants secured from the various plundered colonies of *F. fusca* and *rufibarbis*, on these and other expeditions, which he did not observe, a total of fully 40,000 larvæ and pupæ. Concerning the time of sortie in general he writes (p. 289): "As Huber says, *P. rufescens* nearly always leaves its nest in the afternoon between 2 and 5 o'clock. Von Hagens saw a sortie at 6 P. M.; I have observed two at 1.30 P. M. These are, to my knowledge, the extreme cases. Expeditions have never been observed in the morning. Ebrard says that they depart very late on their first expedition (during June) and thereafter a little earlier each day. I have never observed anything of the kind. I have seen amazons from two different formicaries departing at 2.15 P. M. and at 4 P. M. respectively. On the other hand I have seen amazons of the same colony depart on several successive raids at the same hour. The hour of departure depends as a rule on the temperature; the warmer it is, the later do the amazons depart and *vice versa*. The amazons of the same formicary departed during one year as follows: July 1, 3.15 P. M.; July 23, 5 P. M.; Aug. 10, 3 P. M.; Aug. 12, 1.30 P. M.; Aug. 14, 4.45 P. M., etc. The departure of Aug. 10 and 12 coincided with a pronounced and sudden drop, that of Aug. 14 with a pronounced rise of temperature. According to the formicaries, the

[3] "A Slave-making Foray of the Shining Amazon (*Polyergus lucidus* Mayr)," JOURN. N. Y. ENT. SOC., 16, 1908, pp. 144–151.

[4] Fourmis da la Suisse, 1874.

expeditions begin from the middle of June to the beginning of July (possibly sooner in very warm localities) and end between the middle of August and beginning of the September." Emery,[5] who has succeeded in solving the interesting problem of the establishment of amazon colonies, gives the time of two forays of a colony in northern Italy during 1908 as July 24, 4.30 P. M. and July 25, 3 P. M. and of two forays of this same colony during 1907 as July 16, 4.30 to 5 P. M. and July 19, as 5 to 7 P. M.

Forel is probably correct in supposing that the time of sortie of the amazon army is determined by temperature. We may suppose that a certain optimum, probably near 70° to 75° F., is required by the ants. This is often attained during the sunny afternoon hours of July and August in temperate North America and Eurasia. It would certainly be below the usual maximum diurnal temperature and would bear a certain relation to it, so that it would be reached earlier in the afternoon on hot than on cool days. Thus we could account for the differences in the time of sortie between the Californian amazon colonies and those of the Rocky Mountains, Middle and Eastern States since the average midday temperatures of July at altitudes of 6,000 to 8,000 ft., on the southern and eastern slopes and in the canyons preferred by the ants, is certainly much lower in California than it is in the other localities mentioned. It is not improbable, however, that atmospheric humidity may also be a factor in determining the time of sortie. At any rate, all future descriptions of amazon expeditions, both in this country and abroad, should be accompanied by accurate temperature, barometric and humidity records, for in time such records might enable us to ascertain the precise external stimuli that call forth such periodic behavior as the slave-raids and nuptial flights of ants.

2. The second matter of interest in the observations made at Fallen Leaf Lake is the behavior of the males and females of *breviceps*. Emery has been puzzled by the behavior of these forms in the European *rufescens*. Huber and Forel had witnessed marriage flights of this ant and Burrell[6] described a feeble marriage flight of

[5] Osservazioni ed Esperimenti sulla Formica Amazzone. Rend. Sess. R. Accad. Sci. Ist. Bologna, 1908, 16 pp.; Nuove Osservazioni ed Esperimenti sulla Formica Amazzone, *ibid.*, 1909, 8 pp.; Ulteriori Osservazioni ed Esperienze sulla Formica Amazzone, *ibid.*, 1911, 18 pp.

[6] *Loco citato*, p. 150.

lucidus July 22, 1903. Aug. 20, 1903, I saw a large and very typical flight of *lucidus* subsp. *montivagus* Wheeler near Colorado Springs. Emery observed a colony of *rufescens,* which, during 1907, had no marriage flight but from which winged and deälated females issued and accompanied the workers on their forays. In 1908 the same colony gave off a lot of males which flew away but no females accompanied the raids. The observations on the Californian *breviceps* show that the males and females may stay long in the maternal nest, that some of them may escape from time to time and mate outside the nest and that both winged and fecundated, deälated females may accompany the workers on their raids while a marriage-flight is taking place. A single colony may thus exhibit during the course of a few days combinations of the two extreme conditions noticed by Emery during two seasons. I called attention to the protracted retention in the nest of males and females of *lucidus* in 1908,[7] but before making the observations on the Californian *breviceps* I had never seen the females accompanying the workers on their raids, though both Emery and Forel had seen this repeatedly in the typical *rufescens.* These authors have also failed to notice any inclination on the part of the females to bring home pupæ. My observations leave me skeptical in regard to Emery's assumption that the female *Polyergus* mates inside the nest.

Emery's observations on colonies kept in artificial nests show conclusively that the fecundated and deälated female of *Polyergus* founds her colony by entering a *fusca* formicary, killing its queen by piercing her head with the mandibles and securing adoption in her place by the *fusca* workers. Does the female, while accompanying the foraging army, gain acquaintance with the situations and personnel of the various *fusca* nests in the area dominated by the *Polyergus* colony, so that she can at her leisure select and invade a propitious colony in which to secure adoption? Or does she actually secure adoption in a colony which has just been plundered and is therefore in a depressed and nonresistant state, as seems always to be the case with *fusca* colonies after they have had to submit to this sudden and severe calamity? The former method is suggested by the iso-

[7] "The Ants of Casco Bay, Maine, with Observations on Two Races of *Formica sanguinea* Latreille," Bull. Amer. Mus. Nat. Hist., 24, 1908, p. 640 *nota.*

lated deälated females sometimes found running about on the ground at a distance from the maternal nest, as if looking for a host-colony; the latter method would seem to have many advantages. Perhaps both methods are adopted by different females.

3. The finding on July 24 (p. 108) of a small and evidently incipient *breviceps* colony consisting of an ergatoid or wingless female with about a dozen workers and twice as many *fusca* slaves, is significant, because the female was functioning as the mother of the colony and must therefore have been fecundated. The ergatoid female of the European amazon has been known for more than a century. It was first recognized by Pierre Huber[8] and has been repeatedly taken by Forel, Emery and Wasmann. According to Forel (Fourmis de la Suisse, p. 137), "this singular creature, which is very constant in type, is rather rare. Nevertheless, during certain years some specimens of it are found in most of the formicaries. Its rôle, if it has one, is unknown. Perhaps it can replace the queens in their functions. Dissection has proved to me that its ovaries are identical with those of the queen, etc." Wasmann[9] describes one of these females which he kept in an artificial nest with amazon workers and slaves from April, 1885, to September, 1886. It was treated by the slaves as a true queen, licked, fed and, when disturbed, carried to a place of safety. Its eggs, however, produced only males, showing that it had not been fecundated. In 1908 I published a similar observation[10] on a large colony of *lucidus* which I had under observation for five years in a field near Bronxville, N. Y.: "During four years this colony produced numbers of males and females, both winged and ergatoid, and the winged females lingered for weeks in the nest without deälation. The first week of the past April [1908] I found the whole community with its larvæ and mother queen enjoying the spring warmth in the superficial galleries just under the large flat stones with which I had covered the nest in September, 1903. I captured the queen and part of the colony and transferred them to an artificial nest. Aug. 9 [1908] I again visited the nest, and to my surprise, found it teeming with several hundred mature males clinging to the

[8] Recherches sur les Moeurs des Fourmis Indigènes, 1810, p. 251.

[9] Die zusammengesetzten Nester und gemischten Kolonien der Ameisen, Münster s.W., 1891, p. 84.

[10] Ants of Casco Bay, etc., *loc. cit.*, p. 141, *nota*.

lower surface of the stone, but with no winged or deälated females. Besides the males I found only a single large ergatoid female, several dozen workers and slaves [*Formica incerta*] and half a dozen cocoons enclosing nearly mature male pupæ. Without doubt, the ergatoid had usurped the rôle of the mother queen, and being unfertilized, had produced only male offspring. The comparatively small number of slaves had been able to rear an enormous number of these little creatures although the absence of *incerta* pupæ in the nest indicated that the *Polyergus* workers had made no forays during the past summer." Emery[11] cites an unpublished observation of Wasmann concerning an ergatoid female of *rufescens* which produced workers and must therefore have been fecundated. This observation supports my interpretation of the origin of the *breviceps* colony taken on Angora Peak, Cal., July 24. Emery believes that the ergatoid females may be fecundated in the maternal nest, but this might occur quite as easily outside the nest and on the ground during a marriage flight of the males.

Considerable interest attaches to the ergatoid female of *Polyergus* because it is so much like the only females known to occur in certain tropical ant genera such as *Leptogenys, Onychomyrmex* and *Paranomopone*. It suggests that the ants of these genera once possessed, like *Polyergus,* two kinds of females, one winged and one wingless, and that the colonies for some reason no longer develop the former. In the singular parasitic *Hapagoxenus sublævis* the two forms still occur but in different geographical regions, the winged form in Saxony, as Viehmeyer has shown, and the wingless form in Sweden, as was first established by the classical observations of Adlerz.

POSTSCRIPT.

After the preceding pages were written I received a fourth interesting paper from Professor Emery on the amazon colony which he had under observation from 1908 to 1914.[12] In 1908 and 1909 he succeeded in establishing in artificial nests two amazon colonies with the aid of two fecundated queens that had secured adoption by *fusca* workers. In March 1910, he combined the two formicaries and the

[11] Osservazioni e Esperimenti, etc., 1908, *loc. cit.*, p. 7.

[12] Histoire d'une Société Expérimentale de *Polyergus rufescens,* Rev. Suisse Zool., 23, 1915, pp. 285–400, 2 figs.

single colony thus formed flourished and grew to considerable size by July 18, 1911, when he took it into his garden and observed the behavior of the amazons when he opened the nest and permitted them to make slave-raids on various colonies of *Formica fusca* var. *glebaria* and *F. rufibarbis*. Similar experiments were performed during the summer of 1912 and 1913. July 14, 1914, when he released the colony for the last time in a courtyard of his villa, the ants established themselves in the soil and soon afterwards moved to another more permanent nest. The amazons made several sorties till October 2, but secured no booty, as there were no nests of the slave-species in the courtyard. The observations were very suggestive in connction with the interesting problem as to how the amazon armies are guided to the nests they plunder. Like Forel and myself, Emery believes that exploring workers, which leave the nest singly, ascertain the position of the slave colonies in the environment and are thus able to determine at least the initial direction to be taken by the army when it leaves the nest. I shall not discuss this difficult question here, but will merely call attention in conclusion to the times of sortie of the army as recorded in Emery's paper. These are given as follows:

1911.	Aug.	22—4.30 P. M. and 5.15 P. M.
1912.	"	17—5.00 P. M. and 6.30 P. M.
	"	21—4.20 P. M.
	"	24—4.30 P. M.
	"	28—5.40 P. M.
1913.	July	5—4.50 P. M.
	"	30—5.15 P. M.
1914.	"	16—6.00 P. M.
	"	17—6.30 P. M.
	"	25—7.00 P. M.
	Aug.	8—5.30 P. M. and 6.15 P. M.
	Oct.	2—3.30 P. M.

It will be seen that all but one of the sorties were very late, between 4.20 and 7 P. M., the average time being about 5.30 P. M. This is much later than the average time of sortie of Swiss colonies of *rufescens* or of the Californian *breviceps*, and indicates that the temperature during July and August in northern Italy (presumably near Bologna), in such enclosed spaces as gardens and courtyards, may be

higher in the late afternoon. On Aug. 22, 1911, Aug. 12, 1912, and Aug. 16, 1914, two sorties occurred on the same day. This has also been occasionally observed by Forel in the field. On Aug. 9, 1914, there were three sorties, but the time of their occurrence was not recorded.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LX. No. 11.

THE STANFORD EXPEDITION TO BRAZIL, 1911, JOHN C. BRANNER, DIRECTOR. THE ANTS OF BRAZIL.

By William M. Mann.

With Seven Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
September, 1916.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUTENANT COMMANDER L. M. GARRETT, U. S. N., COMMANDING, PUBLISHED OR IN PREPARATION:—

A. AGASSIZ. V.[5] General Report on the Expedition.
A. AGASSIZ. I.[1] Three Letters to Geo. M. Bowers, U. S. Fish Com.
A. AGASSIZ and H. L. CLARK. The Echini.
H. B. BIGELOW. XVI.[16] The Medusae.
H. B. BIGELOW. XXIII.[23] The Siphonophores.
H. B. BIGELOW. XXVI.[26] The Ctenophores.
R. P. BIGELOW. The Stomatopods.
O. CARLGREN. The Actinaria.
R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
H. L. CLARK. The Starfishes.
H. L. CLARK. The Ophiurans.
S. F. CLARKE. VIII.[3] The Hydroids.
W. R. COE. The Nemerteans.
L. J. COLE. XIX.[19] The Pycnogonida.
W. H. DALL. XIV.[14] The Mollusks.
C. R. EASTMAN. VII.[7] The Sharks' Teeth.
S. GARMAN. XII.[12] The Reptiles.
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C. A. KOFOID and E. J. RIGDEN. XXIV.[24] The Protozoa.
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JOHN MURRAY and G. V. LEE. XVII.[17] The Bottom Specimens.
MARY J. RATHBUN. X.[10] The Crustacea Decapoda.
HARRIET RICHARDSON. II.[2] The Isopods.
W. E. RITTER. IV.[4] The Tunicates
B. L. ROBINSON. The Plants.
G. O. SARS. The Copepods.
F. E. SCHULZE. XI.[11] The Xenophyophoras.
HARRIET R. SEARLE. XXVIII.[28] Isopods.
H. R. SIMROTH. Pteropods, Heteropods.
E. C. STARKS. XIII.[13] Atelaxia.
TH. STUDER. The Alcyonaria.
JH. THIELE. XV.[15] Bathysciadium.
T. W. VAUGHAN. VI.[6] The Corals.
R. WOLTERECK. XVIII.[18] The Amphipods.

[1] Bull. M. C. Z., Vol. XLVI., No. 4, April, 1905, 22 pp.
[2] Bull. M. C. Z., Vol. XLVI., No. 6, July, 1905, 4 pp., 1 pl.
[3] Bull. M. C. Z., Vol. XLVI., No. 9, September, 1905, 5 pp., 1 pl.
[4] Bull. M. C. Z., Vol. XLVI., No. 13, January, 1906, 22 pp., 3 pls.
[5] Mem. M. C. Z., Vol. XXXIII., January, 1906, 90 pp., 96 pls.
[6] Bull. M. C. Z., Vol. L., No. 3, August, 1906, 14 pp., 10 pls.
[7] Bull. M. C. Z., Vol. L., No. 4, November, 1906, 26 pp., 4 pls.
[8] Mem. M. C. Z., Vol. XXXV., No. 1, February, 1907, 20 pp., 15 pls.
[9] Bull. M. C. Z., Vol. L., No. 6, February, 1907, 48 pp., 18 pls.
[10] Mem. M. C. Z., Vol. XXXV., No. 2, August, 1907, 56 pp., 9 pls.
[11] Bull. M. C. Z., Vol. LI., No. 6, November, 1907, 22 pp., 1 pl.
[12] Bull. M. C. Z., Vol. LII., No. 1, June, 1908, 14 pp., 1 pl.
[13] Bull. M. C. Z., Vol. LII., No. 2, July, 1908, 8 pp., 5 pls.
[14] Bull. M. C. Z., Vol. XLIII., No. 6, October, 1908, 285 pp., 22 pls.
[15] Bull. M. C. Z., Vol. LII., No. 5, October, 1908, 11 pp., 2 pls.
[16] Mem. M. C. Z., Vol. XXXVII., February, 1909, 243 pp., 48 pls.
[17] Mem. M. C. Z., Vol. XXXVIII., No. 1, June, 1909, 172 pp., 5 pls., 3 maps.
[18] Bull. M. C. Z., Vol. LII., No. 9, June, 1909, 26 pp., 8 pls.
[19] Bull. M. C. Z., Vol. LII., No. 11, August, 1909, 10 pp., 3 pls.
[20] Bull. M. C. Z., Vol. LII., No. 13, September, 1909, 48 pp., 4 pls.
[21] Mem. M. C. Z., Vol. XLI., August, September, 1910, 323 pp., 56 pls.
[22] Bull. M. C. Z., Vol. LIV., No. 7, August, 1911, 38 pp.
[23] Mem. M. C. Z., Vol. XXXVIII., No. 2, December, 1911, 232 pp., 32 pls.
[24] Bull. M. C. Z., Vol. LIV., No. 10, February, 1912, 16 pp., 2 pls.
[25] Mem. M. C. Z., Vol. XXXV., No. 3, April, 1912, 98 pp., 8 pls.
[26] Bull. M. C. Z., Vol. LIV., No. 12, April, 1912, 38 pp., 2 pls.
[27] Mem. M. C. Z., Vol. XXXV., No. 4, July, 1912, 124 pp., 12 pls.
[28] Bull. M. C. Z., Vol. LVIII., No. 8, August, 1914, 14 pp.
[29] Mem. M. C. Z., Vol. XLII., June, 1915, 397 pp., 109 pls.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LX. No. 11.

THE STANFORD EXPEDITION TO BRAZIL, 1911, JOHN C. BRANNER, DIRECTOR. THE ANTS OF BRAZIL.

By William M. Mann.

With Seven Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
September, 1916.

No. 11.— *The Stanford Expedition to Brazil, 1911. John C. Branner, Director. The Ants of Brazil.*

Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 114.

By William M. Mann.

As Entomologist to the Stanford Expedition, it was my privilege to spend the summer and fall of 1911 making collections in various parts of Brazil. Natal and Ceará on the East Coast were our headquarters for the first three months, and from these stations side trips were made to nearby points. In the early part of July, when the other members of the party returned to the States, Dr. Fred Baker and I remained at Pará, and subsequently went up the Amazon to Manaos. We hoped to be able to get into the region of the upper Rio Madeira. Our hopes were more than realized, for Mr. May, senior member of the firm, May, Jeckyll & Randolph, then engaged in constructing the Madeira-Mamoré Railroad, took an active interest in our work and provided us with transportation from Manaos to Porto Velho on the little steamer owned by the company, and with letters to several of the engineers and medical men. From the time of our arrival at Porto Velho till we left, we were shown the greatest hospitality by everyone in the foreign colony. Dr. James Laidlow and Messrs. Nixon and Troop cared for us in their homes at Porto Velho, while along the line of the railroad and in the construction camps everyone gave us all possible assistance. Some of the men, as Messrs. H. N. Burton and Fry, themselves interested in insects, collected during spare hours and generously turned over to us such specimens as we wanted. It is impossible adequately to express our appreciation of the kindness with which we were treated while on the Madeira-Mamoré.

As a great deal of territory was covered, and several distinct faunal regions visited, it seems advisable to give a list of the localities in which collections were made. These are:

State of Rio Grande do Norte.

Natal. On the coast, in an arid, sandy and wind-swept district.

Ceará-Mirim. North of Natal. The immediate vicinity of the town is well cultivated, with fields of cane and cotton, and considerable woody land and abundant water.

Baixa Verde. The terminus of a little railroad running out of Natal in a northwesterly direction. The surrounding country is hilly and very arid, with much scrub and cacti. At the time we collected here everything was dry and collecting was to be had only beneath stones, with which the ground was strewn.

State of Parahyba.

Independencia. Dr. Heath and I spent a week at the little village of Itamatahy, near Independencia, as guests of Messrs. Nye and Tessire, engineers on the local railroad. The country is hilly, with abundant vegetation and water. Bamboo breaks afforded interesting collecting.

State of Ceará.

Ceará. On the coast in extremely arid surroundings. There is a good stream near the city, along which was a fairly abundant fauna. This and the following are type localities of many of the ants described by Mayr and Forel.

Baturité Mountains. Mr. Williams, the Director of the railroad between Ceará and Inixadá gave the members of the Expedition an excursion to the latter village. *En route* it was possible to collect at several points in the mountains.

Maranguapé Mountains. Mr. Lieb, Assistant Geologist of the Expedition, and the writer made a side trip into these mountains and collected for a day. In the humid canyons and on the hillsides were taken several species not found elsewhere.

State of Pará.

Pará. Nearly all of the material labeled Pará was taken in the forest on the outskirts of the suburb Souza.

Santarem. Visited on our return trip down the river. We were able to spend only a few hours here, chiefly among the scrub in the sandy region back of the town.

State of Amazonas.

Itacoatiara. On the north bank of the Amazon, about forty miles below the mouth of the Rio Madeira.

Porto Velho. The starting point of the Madeira-Mamoré Railroad, near the border of Matto Grosso, about three miles from the Brazilian village of São Antonio.

State of Matto Grosso.

Abunã. On the Brazilian side of the river, nearly opposite the mouth of the Rio Abuna which forms the boundary of Bolivia and the Brazilian State of Matto Grosso.

Madeira-Mamoré R. R. Camps. Collections were made at a number of construction and other camps along the line of the railroad. The numbers of the camps are given as data. The locality can be most exactly expressed by giving the distances in kilometers from Porto Velho. These are:

Camp No. 28	170 kms.
" " 39	284 "
" " 41	306 "
" " 43	325 "

My study of the collection of Formicidæ has been made possible through the aid of Prof. W. M. Wheeler who has constantly followed the course of my work and generously permitted me to use his extensive collections and library at all times.

I wish to thank Dr. J. C. Branner, through whom I was enabled to accompany the expedition, and Dr. Fred Baker, Dr. Harold Heath, Prof. E. C. Starks and Messrs. Olaf Jenkins, Earl Leib and George Branner, members of the Stanford Expedition, as well as Prof. Chas. T. Brues of the Bussey Institution, all of whom have assisted me in various ways.

PONERINAE.

1. *Acanthostichus brevicornis* Emery.

Three workers taken from beneath a deeply imbedded stone at Independencia, agree closely with Emery's description of *A. brevicornis* from Cayenne. The length varies from 3 to 6 mm. The head is considerably longer than broad, with straight, parallel sides. The

antennal scapes are short and broad. There was only a small number of workers together and all but three escaped.

2. *Paraponera clavata* (Fabricius).

Found commonly at Pará, Manaos, and along the Rio Madeira at Abuná, Porto Velho, and Camps 39 and 41. ♀ ♀.

Next to *Dinoponera grandis* Guérin, this is the largest of the Brazilian ants. It is much more widely distributed than *D. grandis*, occurring from Central America to Paraguay. In habit it is diurnal. The colonies are composed of a small number of individuals, which nest in the ground, generally among the roots of trees or shrubs.

3. *Platythyrea angusta* Forel.

A series of workers from Porto Velho, Abuná, and Madeira-Mamoré Camp 39 agrees well with the description, but have the anterior femora much swollen at the base. Dr. Forel recently showed me the type, which also has enlarged femora. This species, originally described from Trinidad, is more slender than the other South American forms, and the petiole is twice as long as broad. These characters, and the structure of the femora distinguish it from the others.

4. *Platythyrea incerta* Emery.

A single worker from Madeira-Mamoré Camp 41 agrees closely with Emery's description. It differs from *P. punctata* in being much larger (length 8 mm.) and in having the head shorter and the punctuation considerably coarser.

5. *Platythyrea meinerti* Forel.

Plate **1**, figs. 2, 3; Plate **7**, fig. 53.

A colony of this species was found at Pará in one part of a termite nest, a favorite nesting place of the genus, which is probably largely termitophagous in habit. This species is characterized by the strongly bisinuate petiolar node and the large eyes, which are as long as their distance from the anterior border of the head. A full-grown larva is shown Plate **7**, fig. 53.

The following table may help in separating the South American species of Platythyrea.

A. Mandibles dentate.
Length 8 mm. (Surinam).....*sinuata* Roger.
AA. Mandibles without teeth.
a. Eyes as long as their distance from anterior border of head; petiole strongly bisinuate, the middle portion prolonged into a short beak. Length 7.5 mm. (Venezuela, Brazil).....*meinerti* Forel.
aa. Eyes smaller, petiole feebly sinuate.
b. Petiole from above more than twice as long as broad, as long as first segment of gaster; femora swollen. Length 6.7 to 7.7 mm. (Trinidad, Brazil).....*angusta* Forel.
bb. Petiole from above less than twice as long as broad, femora normal.
c. Punctures on epinotum very coarse, dilatation of frontal lobes more marked. Length 8 mm. (Venezuela, Brazil). *incerta* Emery.
cc. Punctures on epinotum finer, dilatation of frontal lobes less marked. Length 6 to 7 mm. (Antilles, Central and South America).....*punctata* Smith.

6. *Typhlomyrmex rogenhoferi* Mayr.

One small colony, taken from a rotten log at Para. ♀.

7. *Rhopalopone relicta*, sp. nov.

Plate 1, fig. 4, 5.

Worker. (Plate 1, figs. 4, 5). Length 2.5 mm.

Head, excluding mandibles, distinctly longer than broad, broadest behind eyes, the width at occiput about equal to that at base of clypeus; sides slightly rounded, posterior border feebly concave. Mandibles long, rather slender, the blade minutely dentate; outer border arcuate at middle. Clypeus subtriangular, broadly rounded at anterior border, flattened in the middle. Frontal carinae very short, their basal lobes rounded. Antennae robust; scapes arcuate, extending barely to the occipital corners; first funicular joint as long as the two succeeding joints together; joints 3 to 9 broader than long; apical

joint twice as long as the penultimate. Eyes small, convex; situated at middle of sides of head. Prothorax slightly transverse, rounded dorsally and laterally. Promesonotal suture faintly impressed. Meso-ëpinotal suture not discernable. Epinótum in profile slightly convex above; its base rounding into the declivity and equal to it in length. Petiole from above transverse, sides rounded; in profile deeper than thick, anterior surface nearly straight, the posterior concave; ventral surface with a large flat tooth anteriorly. Gaster about as long as the thorax and epinotum together; first and second segments subequal, the former with a large anteroventral tooth. Legs robust; posterior coxa armed with a large curved spine.

Sublucid. Head regularly, longitudinally striate and rugose. Thorax and epinotum shining, sparsely punctate, their pleurae coarsely striate transversely. Epinotal declivity transversely striate. Petiolar node with transverse rugæ. Gaster with coarse longitudinal striæ. Legs finely punctate and shining.

Head, antennae, body, and legs with fine short pilosity.

Color brownish red; legs, mandibles, and antennae brownish yellow. Pilosity white.

Described from several workers taken at Madeira-Mamoré Camp 39.

This distinct species is the first Rhopalopone to be recorded from America, the four other known species inhabiting Borneo and New Guinea.

8. *Holcoponera striatula* Mayr.

Very common in the vicinity of Natal, where it was nesting beneath stones and logs, in rather large colonies. One colony was found at Pará. ☿ ♀.

9. *Holcoponera mölleri* Forel.

A single worker from Madeira-Mamoré Camp 39 agrees with Forel's description of this species from Blumenau. It is larger than *H. striatula*, the mandibles are more coarsely striate and all the funicular joints are distinctly longer than broad. In its other characters it is very similar to *H. striatula*.

10. *Ectatomma* (*Ectatomma*) *quadridens* (Fabricius).

Plate 7, fig. 54.

This species was very common at Independencia, Ceará-Mirim, Pará, Itacoatiara, and Manaos. In a nest excavated at the first named locality, the brood chambers were about two and a half feet beneath the surface, in very hard dry earth. Although *E. quadridens* is very common in collections, the male appears to be undescribed.

Male. Length 10 mm.

Head, excluding mandibles, as broad as long, with rounded occipital border. Cheeks two thirds as long as eye. Mandibles well developed, shaped like those of the worker, but smaller. Eyes and ocelli large and convex. Antennae slender, the scape thick and short, about half as long as eye; first joint of the funiculus one third as long as the scape, joints 3–12 cylindrical, four to five times as long as broad; apical joint one and a third times the length of penultimate. Pro- and mesothorax rounded above and at sides. Epinotum rounded; the declivous surface broad and flat, feebly marginate at base, with small lamellate tubercles. Node rounded, transverse, its height about equal to its length; anterior surface flat; with a tubercle anteroventrally.

Head and thorax opaque, rugulosely striate. Mandibles coarsely striate. Antennae finely punctate. Node and first two segments of gaster subopaque, the latter densely striolate longitudinally.

First four joints of antennae sparsely, the rest thickly pubescent, with a few short, erect hairs. Head and thorax with pubescence and a few erect hairs. Node devoid of pubescence, but pilose. Gaster sparsely pubescent and abundantly pilose. Legs finely pilose.

Color black; genitalia brown. Wings (length 6.5 mm.) infuscated; veins and stigma fuscous.

The larva is shown Plate 7, fig. 54.

11. *Ectatomma* (*Ectatomma*) *ruidum* (Roger).

Less abundant than the preceding species. Found at Ceará-Mirim, Manaos, and Camps 39 and 41 Madeira-Mamoré RR. ♀.

12. *Ectatomma* (*Ectatomma*) *tuberculatum* (Olivier).

Common at Pará, Itacoatiara, Manaos, and along the Rio Madeira. ☿ ♀.

Workers are often seen moving slowly about or remaining motionless on the stems and leaves of trees and shrubs. The species is partly nocturnal in habit and often enters houses and hunts about for other insects that come to the lights. A nest which I dug out was in the ground among the roots of a plant, about twelve inches below the surface.

13. *Ectatomma* (*Ectatomma*) *confine* Mayr.

Plate 1, fig. 8.

A single worker (Plate 1, fig. 8), which agrees well with Mayr's description, was taken at Porto Velho. Apparently the species has not been recorded since Mayr described it from a Colombian specimen.

The structure of the pronotum is very characteristic. The middle tubercle is prolonged and flattened above, and laterally compressed in front of the pleural spines so that it has the form of a short, thick carina. The lateral spines on the pronotum are short, flattened, and triangular; the epinotal spines are prominent. The sculpture of the head is coarse, that of the rest of the body delicate. The head, thorax, and abdomen are sparsely beset with coarse, erect hairs.

14. *Ectatomma* (*Gnamptogenys*) *concinnum* (F. Smith).

Plate 1, fig. 7.

Workers (Plate 1, fig. 7) were found at Porto Velho, Abuná, and Madeira-Mamoré Camp 39.

15. *Ectatomma* (*Gnamptogenys*) *tortuolosum* F. Smith.

Plate 1, fig. 6.

Worker. (Plate 1, fig. 6.) Length 7 mm.

Head, excluding mandibles, a little longer than broad, with slightly convex sides, narrowly rounded posterior corners and concave border. Clypeus nearly as long as broad, the surface depressed; anterior border straight. Mandibles slender, the blade edentate. Antennae robust; scape thickened apically, extending one fourth its length beyond the occipital corners; funicular joints 1 to 3 elongate, subequal; joints 3–6 globose, a little longer than broad. Eyes moderately large, convex, situated at middle of sides of head. Thorax

above without sutures. Prothorax rounded above in front and at sides. Epinotum in profile nearly straight at base, the declivity sloping gradually. Petiole longer than broad, broadest behind, with rounded posterior border, straight sides and straight, margined anterior border, the corners of which project angulately; in profile higher than long, rounded above. Gaster short and thick. Legs rather slender.

Head shining, longitudinally striate, the striae coarse and regular, becoming oblique at sides, perpendicular on cheeks; the intervening ridges rounded. Thorax shining, sculptured similarly to head; the prothoracic striae longitudinal at middle, arcuate at sides, forming a somewhat concentric pattern. Striae of epinotum transverse at middle, obliquely longitudinal at sides. Petiole concentrically striate. Gaster subshining, the first two segments longitudinally striate.

Head, body, and legs with abundant, rather fine erect hairs.

Color piceous, legs and antennae fuscous.

The specimen before me has the antennae mutilated.

Described from a worker found dead, at Madeira-Mamoré Camp 41. The specimen runs to *E. tortuolosum* in Emery's key to the species, and answers to Smith's very superficial description, but differs from the form considered as this species by Emery (Studi sulle formiche della fauna Neotropica. Bull. Soc. ent. Ital., 1896, **28**, p. 51) in the structure of the petiole, which forms an acute angle above in profile in *E. tortuolosum*. It is doubtful whether this or Emery's specimen (which came from Pará) belongs to Smith's species.

16. *Ectatomma* (*Gnamptogenys*) *sulcatum* (F. Smith).

Several workers and females from Porto Velho. The striae extend the entire length of the thorax; those of the node and first gastric segment are also longitudinal, but slightly arcuate on the sides. The color is bright ferruginous, with the head black and the mandibles pale yellow.

17. *Ectatomma* (*Gnamptogenys*) *sulcatum* var. *nitens*, var. nov.

Three workers from Manaos and Independencia.

In form and sculpture this variety is identical with the typical form, but is entirely black in color, except the mandibles which are yellow.

18. *Ectatomma* (*Gnamptogenys*) *annulatum* Mayr.

Not uncommon at Porto Velho, and Camp 39, Madeira-Mamoré R. R., where several females and workers were taken. Two workers from Pará are also in the collection. A nest was found in a cavity of a fence post, where the wood was rotten.

The striolation of *E. annulatum* is very delicate, longitudinal on the pro- and mesonotum, transverse on the epinotum and petiolar node. The specimens vary in color from fuscous to ferruginous. The legs of all are yellowish brown, with a fuscous blotch at apex of tibiae and femora.

19. *Dinoponera grandis* (Guérin).

Several specimens of the typical form of the species, as designated by Emery (Ann. Soc. ent. Belg., 1901, **45**, p. 47) were taken at Pará, in the suburb Souza. The subopaque gaster, abundance of hairs on the body and the well-developed ventral tooth of the pronotum, are characteristic of this form. The petiole in profile is quadrangular, as high behind as in front, and the thorax and gaster bear fine recumbent pubescence, which gives a brownish appearance to the body.

20. *Dinoponera grandis* subsp. *lucida* Emery.

Two workers from Porto Velho.

This subspecies differs from the typical *D. grandis* in having the prothorax, node, and gaster shining; the petiole from above is more slender and in profile has the upper surface convex instead of nearly straight; the prothoracic spine is lacking; the pubescence of the thorax is more dense.

21. *Dinoponera grandis* subsp. *mutica* Emery.

Plate **7**, fig. 55.

Abundant at Natal, Baixa-Verdé, Ceará-Mirim, and Independencia. The prothoracic spine is absent; the node shorter than in the typical *D. grandis*, in profile pointed in front, rounded behind. The body is more shining, the pilosity and pubescence less conspicuous.

There were several colonies of *D. mutica* in the vicinity of our house

at Natal, nesting among scrubby vegetation. The typical *D. grandis*, in the forest, is seen foraging all through the day, but *D. mutica*, living in more open localities, is crepuscular or nocturnal, though it forages also on cloudy days. The formicaries were always in thickets, among the roots of trees. The mounds thrown up are low, generally not over six inches in height, and often up to three feet in diameter. Dr. Heath and I dug out one nest. The tunnels extended along the underside of roots, which formed projecting roofs. Along these tunnels were frequent broad and flat chambers, which contained the brood. In spite of the large size and powerful sting, the ants were not very pugnacious, though those in a chamber would sally out when it was cut into.

Dinoponera grandis and its varieties are known to the Brazilians as the "Tocandero," and according to them its sting causes fever.

A larva (Plate **7**, fig. 55) probably immature, in alcohol measures 13 mm. in length. The body is thick and the neck short. All the segments are distinct, with fine, short hairs. The head is glabrous, from above a little broader than long; the mandibles long and acuminate. The thorax and abdomen are tuberculate, the tubercles very large and prominent, rounded above, each bearing a small sensory papilla at the middle. Each segment has three of these large tubercles laterally, and a smaller, less conspicuous one basally.

22. *Dinoponera grandis* var. or subsp.

Male. Length 21 mm.

Head, including the mandibles, as broad as long, very convex behind. Eyes very large and long occupying the entire sides of head, the inner border deeply emarginate; ocelli very large and convex. Clypeus convex, the anterior border truncate. Mandibles small, pointed at apex, with a small tooth at middle of inner border. Antennae a little shorter than the body; first funicular joint twice as broad as long; joints 2–11 very long, cylindrical, each slightly shorter and more slender than the preceding. Thorax robust; scutellum short, triangular, broadly rounded at apex. Epinotum evenly rounded, without distinct base or declivity, unarmed. Petiole nearly twice as long as broad, narrowed in front, with nearly straight sides; in profile longer than high, flattened above, the anterior slope gradual, more abruptly sloping behind, the anteroventral surface with a broad, triangular projection. Gaster long, and slender, the length three

times the breadth. Genitalia prominent; the valves broad, rounded at apex; cerci long and slender. Wings large, extending almost to tip of gaster. Legs very long and slender.

Body and legs shining. Antennae opaque, coarsely, densely punctured; sparsely pubescent, and having much very long, fine erect hairs, which on the apical joints are shorter and confined to the tips; pubescence of apical joint more dense than the rest. Thorax with long silky pubescence, most abundant on the pleurae, and very fine erect hairs sparsely distributed. Node without pubescence, but with abundant erect hairs. Gaster with a thin mat of silky pubescence, shorter and finer than that of the thorax; lateral and apical portions with fine erect hairs.

Color rufous, the antennal scape and first five funicular joints fuscous. Wings slightly infuscated, veins and stigma reddish brown. Pile and pubescence yellowish white, except the long antennal hairs which are black.

Described from three examples, which were taken at lights in Independencia. This form which is probably the male of the variety *D. mutica,* the commoner form in this vicinity, is very much like a male thynnid in general habitus. The antennae bear unusually long hairs, which are abundant basally, but thin out and become shorter toward the apex.

23. *Neoponera* (*Neoponera*) *commutata* (Roger).

Porto Velho and Camp 39, Madeira-Mamoré R. R.

24. *Neoponera* (*Neoponera*) *apicalis* (Latreille).

Pará, Porto Velho, Abuná, and Camps 39, 41, Madeira-Mamoré R. R.

25. *Neoponera* (*Neoponera*) *obscuricornis* Emery.

Abuná and Porto Velho. ♀

In general appearance this species is very similar to the preceding. It can be distinguished by the structure of the node. In *N. apicalis* this is sharply margined at the sides, and longitudinally impressed medially to the margin. *Neoponera obscuricornis* has the surface of the node slightly convex, not impressed; the margin is very feeble at the base and entirely obsolete on the apical half.

26. *Neoponera* (*Neoponera*) *latreillei* Forel.

Pará, Porto Velho, and Camps 39, 41, Madeira-Mamoré R. R. ☿

The large size and active movements, with the contrast in color between the black body and yellow tipped antennae make *N. latreillei* one of the most conspicuous ants in the forest.

A small colony, of perhaps thirty individuals, found at Pará, was nesting beneath a banana stalk in a dense thicket. The ants were very timid and ran away quickly, but returned one by one to carry off their brood.

27. *Neoponera* (*Neoponera*) *unidentata* (Mayr).

Pará, Manaos, Porto Velho, and Camps 39, 41 Madeira-Mamoré R. R. ☿ ♀

28. *Neoponera* (*Neoponera*) *bakeri*, sp. nov.

Plate 1, fig. 9.

Worker. (Plate 1, fig. 9). Length 8 mm. Near *N. unidentata* (Mayr). Head, excluding mandibles, longer than broad, subquadrate, sides feebly convex, posterior angles obtuse; occiput concave; carina on cheek strong; clypeus at middle prolonged into a sharp point, concave at sides. Mandibles rather thick, triangular, with twelve small teeth, the apical and two subapical larger than the others and subequal. Eyes convex, a little in front of the middle of head. Antennal scapes extending three eighths their length beyond the occipital corners; apical joint of flagellum nearly twice as long as penultimate. Thorax, seen in profile, moderately convex. Pronotum convex, strongly margined at sides, the margin indistinctly serrate. Mesonotum nearly circular, disc-like. Mesoëpinotal impression shallow, but distinct. Metanotum convex basally; declivity gradual, the surface nearly flat, on either side with a prominent marginal carina on which are three distinct triangular teeth. Node highest in front; anterior surface straight to apex; posterior surface, seen in profile, strongly convex, base slightly concave, margined at sides, margin with three to five distinct teeth. Gaster as long as thorax and head excluding mandibles.

Head coarsely, longitudinally striate, the striae irregular and wavy; mandibles sublucid, smooth. Pronotum more finely transversely striate. Striae of meso- and epinotum coarse, on mesonotum

and disc of epinotum transverse, on sides longitudinally oblique. Node shining, with coarse, transverse striae, which extend around it, broken only by the strong margin. Gaster sublucid; first segment minutely punctate.

Head and thorax with fine recumbent pubescence, and abundant, scattered, erect pile. Node without pubescence, and with scarce pilosity. Gaster with a dense mat of fine recumbent pubescence, and abundant, scattered, erect pile.

Femora and tibiae with short erect hairs, smooth and shining.

Color black; mandibles, antennae, tibiae, and tarsi brown, femora yellow. Pile and pubescence pale yellow.

Female. Length 11 mm.

Similar to worker. The eyes are small, ocelli minute. The thoracic striae are proportionately much finer than in the worker, and transverse. The declivity of the epinotum is abrupt, the base shallowly margined; margin with fine teeth. Node as in worker.

Pile and pubescence as in worker. Color black; legs, mandibles, and extreme tip of antennae brown.

Wings. Length 7.5 mm. Infuscated, veins and stigma fuscous.

Described from one female from Porto Velho and several workers taken on the Rio Madeira at Porto Velho, and Camps 39 and 41 on the Madeira-Mamoré R. R. This species in form is similar to *N. unidentata* (Mayr), which was common in the same region, but the very distinctive coarse sculpture of the head, thorax, and especially of the node, and the denticulate margins of the epinotal declivity and the posterior surface of the node, as well as the different nodal structure seem to constitute differences more than subspecific.

29. *Neoponera* (*Neoponera*) *villosa* (Fabricius).

Pará, Manaos, Itacoatiara, Porto Velho, Abuná, and Camps 39, 41 Madeira-Mamoré R. R., Brazil; and Abuná, Bolivia.

This is one of the commonest ponerine ants of Brazil, and one of the most widely distributed species, ranging from Texas to Paraguay.

30. *Neoponera* (*Neoponera*) *carinulata* (Roger).

Plate **1**, fig. 10.

Worker. (Plate **1**, fig. 10). Length 8 mm.

Head, excluding mandibles, scarcely longer than broad, very slightly narrowed in front; occipital border nearly straight; sides feebly

convex; clypeus prolonged at middle, the apical portion narrowly rounded; frontal carinae above antennal lobes slightly diverging outwardly. Mandibles triangular; about $\frac{5}{8}$ as long as head, the blade with twelve distinct teeth. Carinae on cheeks very distinct. Antennae slender; the scapes extending one third their length past occipital corners; funicular joints all longer than broad, increasing in size toward the tip. Prothorax transverse, longitudinally carinate at middle, flattened above; sides strongly margined, in profile slightly convex. Mesonotum circular, with a median, longitudinal carina, on either side of which the surface is depressed; in profile flat. Epinotum in profile evenly convex, with no appreciable angle between base and declivity; anterior portion rounded above and at sides; declivity margined, with an indistinct tubercle at middle of margin; surface flat. Petiole as broad as long, broadest behind, sides evenly convex; posterior margin straight, in profile three fourths as thick as high, with anterior surface horizontal from base to two thirds the distance to apex, then inclined to apex; posterior surface with a disc at middle, rounded on the sides. Gaster cylindrical, as long as thorax and petiole together.

Somewhat shining. Mandibles finely striate. Head foveolately punctate; thorax and node finely punctate, the epinotal pleurae striolate.

Head, thorax, and node with sparse, fine, appressed pubescence and scattered, erect hairs. Posterior surface of node smooth and shining. Gaster rather densely pubescent and with scattered, long pile. Legs sparsely pubescent and pilose.

Color black; antennae, mandibles, and legs brown. Pile and pubescence silvery.

Described from two workers taken at Abuná.

31. *Neoponera* (*Neoponera*) *crenata* Roger subsp. *moesta* Mayr.

One colony was found at Porto Velho.

32. *Neoponera* (*Neoponera*) *stipitum* Forel.

A single worker from Camp 41, Madeira-Mamoré R. R. agrees very well with a cotype from Colombia in the Wheeler collection.

33. *Neoponera* (*Neoponera*) *cavinodis*, sp. nov.

Plate 2, fig. 14.

Worker. (Plate 2, fig. 14). Length 10 mm.

Near *N. luteola* (Roger). Head, excluding mandibles, longer than broad; sides convex, base slightly concave, posterior angles rounded; clypeus extended at middle into a triangular projection, the sides arcuately impressed. Mandibles elongate, acute at apex, with twelve teeth, the basal of which are small and those apically larger; the apical tooth is long and pointed, attached at base to this is a smaller sharp tooth, about half as long, and basal to this another, slightly longer and more acute than the subapical. Eyes convex, situated a little in front of middle of head. Scape of antenna extending three eighths its length past occiput; joints 1–10 of flagellum subequal in length, gradually thicker towards the apex; apical joint $1\frac{1}{2}$ times length of penultimate. Pronotum slightly convex, sides feebly margined, forming an angle with the nearly flat pleurae; disc at middle with a shallow, but distinct longitudinal impression. Mesoëpinotum in profile very slightly convex, rounded at sides posteriorly, and in back, the mesoëpinotal suture scarcely distinguishable: declivity of epinotum rather flat, with feeble margin at sides; above forming a rounded angle with the basal portion; seen from behind spear-shaped, the apex with a short longitudinal impression. Petiole higher than thorax, anterior surface evenly rounded to apex, the middle of base very slightly convex; apex projecting backward over the posterior surface; posterior surface receding anteriorly, concave above, slightly convex below. Gaster as long as head and thorax.

Mandibles subshining, with scattered, coarse punctures. Head subopaque, very finely transversely striate and with minute punctures. Thorax and anterior surface of petiolar node sublucid, finely punctate and delicately reticulate. Gaster finely punctate. Legs shining. Head and thorax with fine pubescence and long scattered pile. Clypeus with several long hairs. Anterior surface of node with appressed pubescence, the posterior surface glabrous. Gaster thickly pubescent and with long scattered hairs. Femora and tibiae with suberect hairs.

Color brown, head and gaster darker than the thorax. Legs yellow.

Pile and pubescence pale yellow.

Described from a worker taken at Porto Velho.

In general appearance *N. cavinodis* resembles *N. crenata* but is much larger and the node is entirely different.

34. *Pachycondyla crassinoda* (Latreille).

Taken at Pará, Porto Velho, and Madeira-Mamoré Camp 39.

35. *Pachycondyla harpax* (Fabricius).

Common at Pará Manaos, Porto Velho, Abuná, and Camp 41, Madeira-Mamoré, R. R.

36. *Euponera* (*Trachymesopus*) *stigma* (Fabricius).

This species, which is common everywhere in the American tropics is represented in the collection by workers and females from Pará, Itacoatiara, Manaos, Porto Velho, Abuná, and Camps 39 and 41, Madeira-Mamoré R. R. Rotten logs and beneath bark are its favorite nesting places.

37. *Belonopelta jeckylli*, sp. nov.

Plate **2**, fig. 12, 13.

Worker. (Plate **2**, fig. 12, 13). Length 4.5 mm.

Head very thick dorsoventrally; excluding mandibles, a little longer than broad, broadest anteriorly, with straight sides, narrowly rounded occipital corners and feebly concave occipital border. Clypeus convex; at anterior border armed with a stout spine at middle. Mandibles five eighths as long as head, slender, bidentate at apex; the inner border with a large tooth at middle, and a minute one midway between this and the subapical tooth. Antennae robust; the scapes slightly arcuate, thickened distally, almost attaining occipital corners. First funicular joint longer than broad, joints 2–10 slightly transverse, those at the apical end subglobose; apical joint as long as the three preceding together, evenly narrowed from base to apex. Eyes minute, situated at anterior third of sides of head. Prothorax with a thick neck. Pronotum from above, excluding the neck, a little broader than long, rounded in front and at sides, the posterior border concave. Promesonotal suture very strongly impressed. Mesonotum about half the width of pronotum, rounded in front, sides nearly straight, in profile slightly convex. Mesoëpinotal suture feebly impressed. Epinotum twice as long as the mesonotum, and a

little broader, broadest behind, sides nearly straight; in profile gradually elevated from base to angle of declivity; declivity half as long as the basal part, with the surface flattened. Petiole from above very little broader than long, anterior margin straight, at corners of base with prominent lamellate projections, that appear as spines from above; sides rounded, posterior border feebly rounded; in profile deeper than thick, with nearly straight anterior and posterior surfaces, slightly convex above. Gaster cylindrical, strongly narrowed toward apex; the first segment noticeably broader than the second and equal to it in length; a distinct ventral spine present at base. Sting comparatively large. Legs very slender.

Head, thorax, and petiole subopaque, closely, foveolately punctate throughout; pleurae of pro- and mesothorax and anterior coxa obliquely rugulosely striolate; collar transversely rugulose-striolate. Mandibles shining, finely punctate. Antennae and legs subshining, finely punctate. Gaster shining, minutely punctate.

Body, legs, antennae, and mandibles with semierect pilosity.

Head, mandibles, thorax, and petiole fuscous to piceous; borders of the frontal lobes, a round spot on the pronotum, the gaster and legs red. The borders of the gastric segments are infuscated.

Described from several specimens taken at Camp 39, Madeira-Mamoré R. R. The colony was discovered quite accidentally by scratching away some of the leaves and debris with which the ground in the forest is always covered. As far as I could ascertain the ants were traveling in a definite direction. Some of those before me are red in color, evidently immature. Nothing seems to be known regarding the habits of the species of this interesting genus, specimens of which are rare in collections. The four known species have each been found only once.

38. *Ponera trigona* Mayr.

One small colony was found at Manaos.

39. *Ponera opaciceps* Mayr.

Several colonies were taken at Ceará-Mirim.

40. *Ponera distinguenda* Emery.

Numerous workers were taken at Camp 39, Madeira-Mamoré R. R.

41. *Anochetus* (*Anochetus*) *mayri* Emery.

A single worker of this widely distributed species was taken at Baixa Verde.

42. *Anochetus* (*Anochetus*) *bispinosus* (F. Smith).

Plate 1, fig. 11.

Worker. (Plate 1, fig. 11). Length 8 mm.

Head, excluding mandibles a little longer than broad; broadest at eyes; occipital border deeply excised; sides above eyes concave, below sinuate, with the lower surface flattened. Eyes large, and convex. Clypeus between frontal lobes triangular, the surface flat, anterior portion bilobed; border concave at middle. Frontal carinae short. Mandibles about two thirds as long as head, narrow at base, broad and flat anteriorly, the blade edentate to near apex, where there is a short, thick tooth; apex with two long teeth, between which is a smaller, acute tooth. Antennae slender, the scape curved, thickened at middle, extending one eighth its length beyond the occipital corners; funicular joints long and slender, 1 to 10 subequal, apical joint nearly twice the length of subapical. Prothorax much narrowed in front, rounded above and at sides, the posterior border slightly concave. Promesothoracic suture deeply impressed; mesothorax transverse, rounded above and at sides. Mesoëpinotal impression deep and broad; epinotum much narrower than prothorax, straight at sides and above to the declivity, which is very short, and concave; angle with a pair of short, acute, erect spines. Node triangular, the apex with a pair of strong spines, between these broadly concave. Gaster short and thick, the first segment with a small ventral tooth. Sting long and powerful. Legs long and slender.

Head in front subshining, with dense striolae, which extend upward and outward from the frontal area; the remainder of head and the mandibles smooth and very shining. Antennae sublucid, finely pubescent. Thorax shining, rugosely punctate; the mesothoracic pleurae smooth. Node shining, transversely rugose in front, smooth behind. Legs and gaster shining, finely punctate.

Head in front with sparse pubescence, and a few erect hairs. Prothorax, gaster, and coxae with very sparse erect gray hairs. Femora and tibiae thinly pubescent.

Color black, the mandibles, posterior corners of head, and the nodal

spines brownish; legs and tip of gaster ferruginous. Pubescence white.

Described from a single worker taken at Porto Velho. The specimen on which Smith based his description was from Ega (Bates), so it is probable that the species extends over much of the Amazonian region.

43. *Anochetus* (*Stenomyrmex*) *emarginatus* (Fabricius) subsp. *rugosus* Emery.

Male. Length 7 mm.

Head, excluding eyes, considerably longer than broad, rounded behind. Eyes very large, each three fourths as broad as the distance between them, convex, as long as sides of head. Ocelli very large and convex. Mandibles, short, feeble, straight, and without teeth. Clypeus truncate at anterior border; surface broadly foveolately depressed at sides. Antennae very long and slender; the first joint twice as long as the second; joints 3–11 cylindrical, subequal, very long. Thorax narrower than head. Promesonotum convex above. Epinotum in profile evenly rounded. Node longer than broad, in profile triangular, much longer than thick. Gaster long and slender, without a distinct constriction between the first and second segments. Legs long and slender.

Body shining throughout, smooth, with extremely fine semierect pilosity, which is thickest on the antennae. Head and mandibles with a few coarser hairs.

Color light testaceous; antennae, excepting first joint, fuscous; eyes black. Pilosity white.

Described from several specimens taken at Manaos, from colonies which were nesting beneath the bases of living palm-tree leaves. Other colonies were found at Porto Velho beneath logs. The male is very active and takes flight readily.

44. *Odontomachus affinis* Guérin subsp. *mayi* Mann.

The single colony of this form was found living in parabiotic relations with *Dolichoderus debilis* Emery var. *rufescens* Mann, an account of which has already been published.

45. *Odontomachus haematoda* (Linné).

Pará, Manaos, Porto Velho, and Camp 41, Madeira-Mamoré R. R.

46. *Odontomachus haematoda* subsp. *pubescens* Roger.

Very common at Ceará, in the Maranguapé Mts., Independencia, Natal, and Ceará-Mirim. This form is distinguished from the typical *O. haematoda* by the more abundant pile and pubescence, and by the coarser sculpture of the node, which is only feebly striate in the latter form.

47. *Odontomachus haematoda* subsp. *laticeps* Roger.

Porto Velho and Camp 41, Madeira-Mamoré R. R.
This was much rarer than the above mentioned forms.

Dorylinae.

48. *Eciton* (*Eciton*) *hamatum* (Fabricius).

This species, which ranges from Mexico through Central America and over all of tropical South America, was very abundant in the region of the upper Rio Madeira. The armies, found in the woods almost every day, contained enormous numbers of individuals, mostly minors and mediae. One of the big-headed soldiers was encountered at intervals of from ten to twenty feet in the procession. This form is a very conspicuous object on account of its large, light-colored head and the long mandibles which necessitate the body being held high.

The march of the army is exceedingly rapid, and at times very definite in direction. Often it divides and sends some branches up into the tallest trees, while others cross and recross the trails. If an object such as a grub, lizard, or small snake be thrown near the column, it is almost instantly covered with the workers, which bite and sting severely. Unlike some of the other species, *E. hamatum* marches in the daytime and the column travels beneath or over the leaves, over logs, and along the trails. The trunks of fallen trees are a favorite runway. Other species of ants seem to be the usual prey of *E. hamatum*, for larvae and pupae of these made up the greater part of the booty carried by the workers. I observed on several occasions columns descending trees bringing numbers of larvae, pupae, and even adults of *Dolichoderus lugens* Emery, an ant which secretes from the anal glands a large drop of yellow liquid, apparently for defense.

In spite of its large size and the number of individuals in a column, *E. hamatum* is a timid species in comparison with some of the others, such as *E. vagans*. When the column was disturbed by my picking

up some of the individuals, those nearest would turn about and run back, zig-zagging from one ant to another, apparently missing none. An instantaneous antennal communication took place, the warned ant turned also, and almost instantly the whole army was retracing its steps as rapidly as it had come. In a few moments some few would return and then more and in a short time the army would resume its march. At other times a new path was followed. This antennal communication and quick change of direction was observed also in *E. pilosum*, *E. crassicorne*, and *E. burchelli*.

49. *Eciton* (*Eciton*) *lucanoides* Emery.

Columns were found at Madeira-Mamoré Camps 39 and 41.

This species was originally described from Peru. The mandibles are armed with a strong spine on the inner side, a little in front of the middle. I am unable to distinguish the minors and mediae of *E. lucanoides* from those of *E. hamatum* by any single character.

50. *Eciton* (*Eciton*) *burchelli* (Westwood).

This species was moderately abundant on the Rio Madeira, where it was encountered several times at Abuná and at Camp 41, Madeira-Mamoré R. R.

It is rather more aggressive than the other species. When disturbed it attacks the intruder very fiercely and persistently. The pain produced by the sting is severe, but of short duration.

51. *Eciton* (*Eciton*) *rapax* F. Smith.

Two small files of this beautiful species were found at Porto Velho and Camp 41, Madeira-Mamoré R. R. These were running along beneath the loose covering of leaves on the ground.

The ants were very timid and the file dispersed as soon as it was disturbed.

52. *Eciton* (*Eciton*) *rogeri* Dalla Torre.

Several colonies were taken at Camp 39, Madeira-Mamoré R. R.

53. *Eciton* (*Eciton*) *vagans* (Olivier).

Found at Independencia and Baixa Verde, where files were frequently seen toward evening.

54. *Eciton* (*Labidus*) *coecum* (Latreille).

Ceará, Baturité Mts., Natal, Independencia, and Pará, Brazil and at Abuná, Bolivia. This is the most widely distributed and one of the commonest species. It is subterranean in habit, and often found beneath deeply embedded stones and logs. The specimens from Abuná were taken from beneath the putrid carcass of a sheep, and most of the individuals were dead or nearly so, possibly having been overcome by the gases of decomposition.

55. *Eciton* (*Labidus*) *praedator* F. Smith.

Common along the upper Rio Madeira, where it was taken at Porto Velho and Camps 28 and 39 Madeira-Mamoré R. R. One army was seen emerging from the commissary building at the first named station, carrying with it an incredible number of insects, mostly cockroaches. Houses along the railroad were frequently raided at night by *E. prædator*, which is well known to the Brazilians and called by them "cazadoro" (hunter). I had the opportunity of observing one hut while the ants were in possession. The ground was covered with the ants, which swarmed also in the cracks and on the few pieces of furniture, while the owner of the place, a Barbados negress, not accustomed to such intrusions, stood for safety in a puddle of soapy water with which she had attempted to drive the ants away, and begged me to tell her what to do to get rid of them.

56. *Eciton* (*Labidus*) *praedator* subsp. *emiliae*, subsp. nov.

Worker. Differing from the typical form in having the head and body largely opaque; the head more densely punctulate; the thorax and petiole with very few hairs. The pilosity of the gaster is much shorter and the pubescence is more dense; the color is reddish brown, becoming darker on the head.

A large series of this new subspecies was sent to me by Dr. Emilia Snethlage, who collected it at Colonia de Veado, near Obidos. Possibly this is the var. *ferruginea* Norton, which was described from Mexico, but has not been recognized since.

57. *Eciton* (*Labidus*) *crassicorne* F. Smith.

Common at Ceará-Mirim and at Carnahubinha (near Natal) where armies were frequently seen toward evening, either on the ground or in the nests of ground-inhabiting ants.

58. *Eciton* (*Labidus*) *esenbecki* (Westwood).

A single male of this species was taken at light at Porto Velho.

59. *Eciton* (*Labidus*) *sulcatum* (Mayr).

Several males were taken at light at Independencia.

60. *Eciton* (*Acamatus*) *nitens* Mayr.

A rather large colony of this distinct species, was found emerging at dusk from beneath our house at Independencia.

61. *Eciton* (*Acamatus*) *pilosum* F. Smith.

Taken at Independencia and Pará. Several armies were encountered. I collected a number of specimens from a large column which was crossing a railroad track at Independencia, whereupon the column broke up, but formed again and continued its march, this time beneath the rail. A column found in the woods at Pará was travelling underground, except where it crossed a path. Here it emerged and constructed a trail with embankments on each side.

62. *Eciton* (*Acamatus*) *legionis* F. Smith subsp. *crenulatum*, subsp. nov.

Plate 1, fig. 1.

Worker. (Plate 1, fig. 1). Length 3.5 to 5 mm.

Head, excluding mandibles, longer than broad, with nearly straight sides and rounded border; posterior corners angulate. Frontal carinae nearly straight. Outer border of antennal pits strongly carinate. Anterior margin of clypeus flat, projecting at middle. Mandibles stout; the blade edentate. Antennae robust; scape extending a third its length beyond the occipital corners, constricted

near apex, then incrassate; funicular joints a little longer than broad. Eyes distinct, convex. Pronotum twice as long as broad, flat above, the lateral borders elevated into a rounded ridge, which is somewhat thickened at middle. Mesonotum separated from pronotum by a transverse ridge, elevated, concave at middle, strongly margined at sides; mesial to the margin is a longitudinal furrow and on the upper surface two parallel ridges. Base and declivity of epinotum subequal in length, the former flat above with margined sides; surface of the latter evenly convex. Petiole from above longer than broad; flat above, with straight, roundly margined sides. Postpetiole a little longer than broad, broadest behind, rounded above and at sides, anteroventral surface with a distinct tooth.

Head, antennae, thorax, and epinotum sublucid; coarsely, granulosely punctate, throughout, except for a rounded area mesial to the eye, which is finely punctate. Antennae, mandibles, petiole, postpetiole, and legs more shallowly punctate. Gaster smooth and shining.

Head, body, antennae, and legs with long erect hairs; funiculus pubescent.

Color black, antennae, and legs dark reddish brown. Pilosity yellow.

Described from several workers taken from a file that was running beneath the loose bark of a felled tree at Madeira-Mamoré Camp No. 39. This is a very distinct form because of its peculiar sculpture and the strong carinae on the thorax. The latter, especially those at the middle of the mesothorax, are interrupted so that in profile they appear as tubercles.

Myrmicinae.

63. *Pseudomyrma arboris-sancti* Emery.

Plate **3**, fig. 21.

This species is widely distributed in northern South America, and many observations have been made on its relations to the trees of the genus Triplaris with which it appears to be always associated. The tree is well known to the Brazilians and Bolivians by the name of "palo santo," and the ant is called the "taschi." I was told that no living tree was ever without the ants and that the ants never nested elsewhere than in this plant. At Madeira-Mamoré Camp 43 Triplaris was fairly common in the woods and I examined some

dozens, always finding the ant. The colonies contain an enormous number of individuals living throughout the whole plant, all parts of which are hollow. The workers are very aggressive and their sting is quite severe. Whether or not the ants derive any advantage from the tree other than a convenient place to nest I do not know, but there is no doubt that they protect the plant from almost any possible enemy. A Swiss rubber explorer, Otto Schmidt, who has spent many years in the forest and is a keen observer, told me that dead Triplaris plants never contain ant colonies. This suggests that the living plants do offer some attraction to the ant, other than shelter.

64. *Pseudomyrma oculata* F. Smith.

Many workers and females were found at Natal, nesting in hollow twigs. This is one of the smaller, more delicate species, the workers measuring 4 mm. in length. The head is two and a half times as long as broad, the sides parallel with large, flat eyes. The antennal scapes are short, extending only to anterior third of eyes. The petiole is flattened above, twice as long as broad, in profile nearly twice as long as thick. The color is dark fuscous throughout.

65. *Pseudomyrma caroli* Forel.

Many colonies were found at Itacoatiara, nesting in twigs on small trees near the river.

66. *Pseudomyrma nigriceps* F. Smith.

Several workers were found at Abuná and Madeira-Mamoré Camp 41.

This species resembles *P. rufa* in structure and size. The color is different and striking, the head being black, and the rest of the body and appendages testaceous. It was not common.

67. *Pseudomyrma flavidula* F. Smith.

Common at Independencia and Ceará-Mirim, nesting in grass culms, the characteristic nesting site of the species.

68. *Pseudomyrma rufa* F. Smith.

Plate 7, fig. 56.

Worker. Length 6 mm.

Head, excluding mandibles, a little longer than broad, slightly narrowed behind, with convex sides and straight posterior border. Clypeus strongly keeled at middle; anterior border straight. Mandibles well developed, the blades finely dentate. Antennae thick; first funicular joint two and a half times as long as broad; apical joint as long as the two preceding. Ocelli distinct, very close together. Pronotum transverse, depressed, strongly margined at sides, with narrowly rounded humeri. Mesonotum longer than broad, the surface with a disc-shaped impression at the posterior half. Meso-epinotal impression shallow. Epinotum more elevated than pro- and mesonotum, margined at sides basally, the surface distinctly concave; declivity as long as base, in profile straight. Petiole in profile elevated behind, above evenly rounded from base to apex, nearly as high as long; from above, more than twice as long as broad, narrowed above, with roundly margined sides and a narrow longitudinal impression at middle; anteroventral surface with a minute tooth; posterior surface concave. Postpetiole from above a little broader than long. Femora slightly thickened.

Subopaque, granulosely punctate, with very sparse gray pile; pubescence not abundant, pollinose, white. Mandibles finely punctate and pilose.

Color ferruginous, the meso- and epinotum infuscated.

Female (deälated). Length 7.5 mm. (Plate 7, fig. 56).

Head, excluding mandibles, one and a third times as long as broad, the anterior and posterior borders of equal width; sides slightly convex, posterior border straight. Clypeus keeled at middle, the anterior border projecting, with a stout, triangular tooth at middle. Mandibles stout, the blade with a stout, triangular, basal tooth, then three minute teeth and long, pointed apical and subapical teeth. Thorax slender. Pronotum narrower than mesothorax, twice as broad as long, with subparallel, margined sides and narrowly rounded humeri. Petiole seen in profile much as in worker; from above it differs in having the surface flat, and not depressed except at the apex, where there is a deep excavation dividing it into two triangular portions. Sculpture and pilosity much as in the worker; the pubescence of gaster very fine and silky.

Color as in worker, but the head is more infuscated.

Described from a female and several workers found in a twig lying on the ground at Pará.

69. *Pseudomyrma gracilis* (Fabricius).

Many colonies of what seems to be the typical form of this species were taken from twigs at Manaos. The workers (7.5 mm. in length) are colored black, excepting a narrow border at the anterior of head, the clypeus, mandibles, the tips of the front, and intermediate femora and the tarsi, which are ferruginous.

70. *Pseudomyrma excavata* Mayr.

Three workers from Manaos agree with specimens from Costa Rica received from Dr. Forel.

71. *Pseudomyrma laevigata* F. Smith.

One small colony found in a twig at Manaos. The specimens are yellow in color, without trace of maculation.

72. *Pseudomyrma mutilloides* Emery.

A worker each from Itacoatiara and Camp 39 Madeira-Mamoré Railroad.

73. *Pseudomyrma subtilissima* Emery subsp. *tenuissima* Emery.

Taken at Natal and Maranhao. The colony from the latter locality was taken from beneath a loose piece of bark, quite an unusual situation for Pseudomyrma. The type of *P. tenuissima* is from Matto Grosso. Emery records a specimen also from Cayenne.

74. *Pseudomyrma maculata* F. Smith.

One colony from Natal is very doubtfully referred to this species.

The worker is 4 mm. in length.

Head large, broadest in front, sides convex, posterior margin truncate, much broader than pronotum; antennae thickened at apex,

first funicular joint as long as second and third together. Metanotum evenly convex. First petiolar node elongate, slightly petiolate in front, about $1\frac{1}{2}$ times as long as second node, which is globose.

Color yellowish brown, abdomen fuscous; epinotum with a faint median longitudinal fuscous stripe.

75. *Pseudomyrma elegans* F. Smith.

Found frequently in the vicinity of Manaos. This is the only known ground-inhabiting species of the genus. The nests found were in bare places along the roadside. The entrance is circular, about two millimeters in diameter, and directly on the surface, without a mound.

76. *Pseudomyrma elongata* Mayr.

Many colonies found at Ceará-Mirim and Independencia. One large tree at Ceará-Mirim contained hundreds of colonies nesting in hollow twigs and in galls, scarcely a dead twig or a gall being without them. The twigs inhabited are those hollowed naturally or bored by other insects. *Pseudomyrma elongata* is decidedly beneficial to the tree in keeping away insect enemies. The tree mentioned was especially well protected, having several Azteca colonies and some populous wasp nests in addition to the Pseudomyrma.

77. *Pseudomyrma sericea* Mayr var. *altinoda*, var. nov.

Worker. Length 4 mm.

Head one and one third times as long as broad, slightly broader in front than behind, with convex sides and concave posterior border. Clypeus with distinct notch at middle. Eyes large. Antennal scape reaching one third its distance from place of insertion to posterior border of head. Basal funicular joint not as long as two succeeding joints taken together. Pronotum with well-defined margin. Promesonotal and mesoëpinotal sutures equally pronounced. Mesonotum small, seen in profile lower than pro- and epinotum, transverse, about one half the length of the pronotum. Epinotum longer than pro- and mesonotum together, evenly convex above; its declivity shorter than length of basal surface; angle between the two surfaces much rounded. Petiole two thirds as long as thorax, its nodes higher than epinotum, equal in length; anterior node convex in front,

declivous behind; posterior node nearly globose, broader than base of first segment of gaster. Gaster about as long as thorax. Legs robust.

Body opaque, everywhere with a fine mat of pale pubescence, and short, erect, pale pile.

Color fuscous, antennae and legs lighter. Differs from typical *P. sericea* in smaller size and fuscous color. *Pseudomyrma sericea* is black throughout, and the gaster is more robust.

Described from two workers from Porto Velho and one from Camp 39 Madeira-Mamoré R. R.

78. *Pseudomyrma gracilis* Fabricius subsp. *carapuna*, subsp. nov.

Worker. Length 10 mm.

Head, excluding mandibles, slightly longer than broad, contracted behind, with convex sides and slightly concave occipital border. Mandibles large and thick, with finely dentate blades. Clypeus small, slightly convex, anterior border truncate at middle. Antennal scape extending past opposite the middle of eye; first funicular joint three times as long as broad and longer than the second, apical joint as long as the two preceding together. Pronotum flat, with straight, distinctly margined sides and narrrowly rounded, projecting humeri. Mesothorax transverse. Mesoëpinotal suture as long as the pro- and mesonotum together, nearly as broad behind as in front; its basal surface margined at sides, shorter than the declivity. Peduncle of petiole nearly as long as the node; node elongate-globose. Postpetiole longer than broad, pyriform, nearly twice as broad as petiolar node. Gaster long and slender. Legs with slightly thickened femora.

Subopaque; petiole, postpetiole, and gaster shining; finely, densely punctate throughout; mandibles subopaque, finely punctate.

Pubescence more abundant than in typical *P. gracilis*, white. Pilosity short and abundant on head and thorax, longer and more sparse on petiole, postpetiole, and gaster; black in color. Head, thorax, epinotum, and legs black, the tarsi brown; petiole, postpetiole, and gaster bright ferrugineous.

Described from two workers taken on a shrub at Abuná. This form is very distinct from the other varieties of *P. gracilis* in its much larger size, and the bicolored body. In the latter respect it resembles *P. agilis* Emery from Central America, but is very much larger.

79. *Pheidole* (*Elasmopheidole*) *aberrans* Mayr.

One colony was found at Independencia. This species is distributed along the east coast, in the more arid localities from north of Cape San Roque to Argentina. Among the specimens before me some of the soldiers have the vertex of head, the thorax and epinotum piceous. Others from the same colony are reddish brown throughout, agreeing in this respect with a series from Buenos Ayres (Silvestri coll.) in the Wheeler collection.

80. *Pheidole* (*Pheidole*) *guilelmi-mülleri* Forel subsp. *mamore*, subsp. nov.

Soldier. Length 4.75 mm.

Head, excluding mandibles, a little longer than broad, slightly narrowed in front, with nearly straight sides, broadly rounded occipital corners and deeply, narrowly concave border. Clypeus convex, the carina short and thick; anterior border nearly straight. Mandibles short, very thick and blunt, the blade without teeth. Frontal carinae broad at base; antennal grooves longer than scapes. Scapes extending a little more than half the distance from eyes to occipital corners. Club shorter than remainder of funiculus; funicular joints 2–7 as long as broad. Eyes small and convex, located at sides of head at anterior third. Pronotum transverse, the sides extended into blunt cones. Promesonotal impression feeble. Mesonotum flat anteriorly; with a narrow transverse depression before the basal margin, which is somewhat elevated; declivous behind. Epinotum broadly depressed at base, the spines very stout, triangular and strongly diverging. Petiolar node in profile wedge-shaped; from above twice as broad as long. Postpetiole three times as broad as the petiole, conical at sides. Gaster elliptical. Legs short, femora and tibiae thickened.

Head subopaque, coarsely striate, striae extending over occiput; clypeus with several coarse punctures anteriorly. Mandibles subopaque; coarsely, sparsely punctate. Thorax subopaque with transverse, interrupted rugae. Epinotum sublucid, with a few fine transverse striae. Petiole and postpetiole closely, finely punctate. Gaster finely punctate, sublucid. Legs shining. Head, antennae, body, and legs with abundant long, rather stiff pile.

Color black, except the legs and apex of antennae which are castaneous.

Worker. Length 2.55 mm.

Head, excluding mandibles, as broad as long; sides and occipital margin evenly rounded. Mandibles long, slender, with three teeth apically. Clypeus slightly convex; anterior border truncate. Antennal scapes extending half their length beyond the occiput. Prothorax rounded, elevated. Promesonotal impression indistinct. Mesonotum in profile convex above, declivous behind. Epinotum flat and narrow above, the sides and posterior border slightly margined; the spines barely perceptible. Node of petiole in profile rounded above. Postpetiole a little broader than long, with rounded sides. Legs long, the femora and tibiae somewhat swollen. Minutely punctate and shining. Base of epinotum transversely carinate. Pilosity as in the soldier.

Color fuscous; petiole, postpetiole, and legs testaceous fuscous.

Female. Length 5.5 mm.

Head, excluding mandibles, broader than long, sides slightly convex; border of occiput only slightly concave. Mandibles similar to those of soldier. Antennae short, scapes extending three fourths the distance to occiput. Eyes large, located in front of middle of head. Other characters as in the soldier. Thorax flattened above, declivous in the epinotal region, the epinotal spines short and stout. Postpetiole twice as broad as the petiole, the sides drawn out into distinct cones. Gaster one and one half times length of head. Sculpture of head similar to that of the soldier. Pro- and mesothorax longitudinally striate. Epinotum sparsely and coarsely punctured. Gaster with fine punctures, shining.

Wings. Length a little over 5 mm. Slightly infuscated. Veins light fuscous.

Described from workers, soldiers, and a single female from a colony taken at Madeira-Mamoré Camp 36. This is a very distinct form, the soldier differing from that of typical *P. guilelmi-mülleri* in its smaller size, darker color, stronger cephalic sculpture, and in being much less shining. The worker is more shining and much darker than the soldier. It is much smaller than the closely related *P. hohenlohei* Forel from Brazil. The very minute epinotal spines of the worker are scarcely more than angles of the margin at the bases.

81. *Pheidole* (*Pheidole*) *wheeleri*, sp. nov.

Plate 3, fig. 23.

Soldier. (Plate 3, fig. 23). Length 3.5 mm.

Head, excluding mandibles, a fourth longer than broad, narrowed in front, with slightly convex sides, broadly rounded occipital corners and narrowly excavated border. Mandibles thick, blunt at apex, with one blunt subapical tooth. Clypeus flat, without a keel; the anterior border at middle rather strongly bisinuate. Frontal area large, triangular. Frontal carinae moderately elevated at base, nearly straight, diverging, extending as far as apex of antennal scapes. Antennal scapes slightly bent at base, thickened at apex; reaching to half the distance between eye and occipital corners. Funiculus short and thick, the club as long as the remainder; first joint twice as long as broad, joints 2–7 broader than long, joints 8–9 longer than broad; apical joint of club as long as the two preceding together. Eye small, flat, located at sides of anterior third of head. Pronotum twice as broad as long, in front narrow and flat; sides from above drawn out into strong conical projections, in front of which the straight side margins converge to the flattened portion. Promesonotal suture discernible, but not impressed. Mesonotum flat above to the posterior fourth, where it is declivous. Mesoëpinotal suture broad and deep. Base of epinotum longer than the declivity, narrowly excavated longitudinally; the sides rounded; base strongly depressed; spines stout, erect, half as long as the base. Petiolar node wedge-shaped in profile; from above, more than twice as broad as long. Postpetiole transverse, one and a half times as broad as the petiole, the sides bluntly conical. Gaster short and oval. Legs short, the femora very much swollen; tibiae thickened at anterior half.

Body, except epinotum, head, mandibles, antennae, and legs shining. Mandibles with very distinct, regular, scattered punctures; clypeus smooth and shining. Cheeks and sides of the anterior portion of front longitudinally striate, the striae short, extending to about opposite the eyes; the spaces between shining. Front with rather strong, regular, widely separated punctures. Pro- and mesonotum with sparse punctures; the conical lateral pronotal projections densely punctate at apex. Epinotum sublucid, shallowly granulosely punctate. Petiole, postpetiole, and gaster sparsely punctate, the posterior portion and sides of the postpetiole transversely rugulose.

Head, mandibles, antennae, body, and legs with rather abundant long silky pile.

Color dark reddish brown, gaster, epinotum, and a spot on the vertex much darker than the rest.

Worker. Length 2 mm.

Head, excluding mandibles, a little longer than broad, as broad in front as behind, with moderately convex sides and nearly straight occipital border. Mandibles long and slender, with long apical and subapical teeth. Clypeus convex, flattened anteriorly, the border concave at middle. Antennal scapes scarcely surpassing the occipital corners; all the funicular joints longer than broad. Eyes little convex; situated at middle of sides of head. Structure of thorax and abdomen similar to that of soldier. Sculpture and pilosity similar to that of the soldier, but the mesonotum is more closely punctate.

Color dark reddish brown throughout.

Described from soldiers and workers taken at Madeira-Mamoré Camp 39. The strongly prolonged sides of the pronotum, which, with the mesonotum, forms a diagonal quadrangle from above, is very characteristic. Both soldier and worker are very brightly shining, with the exception of the epinotum. The punctation of the head and especially that of the mandibles is coarse.

82. *Pheidole* (*Pheidole*) *carapuna*, sp. nov.

Plate **3**, fig. 22.

Soldier. (Plate **3**, fig. 22). Length 3.24 mm.

Head, excluding mandibles, one and a fourth times as long as broad, as broad in front as behind, with slightly convex sides and deeply, narrowly excavated border. Mandibles long and thick, the blade with a large subapical tooth, a large tooth near base and feeble denticles between. Clypeus depressed at sides and anteriorly, with a strong, narrow carina at middle and one on each side, the border rounded. Frontal carinae extending about half as far as the tips of antennal scapes. Eyes small, flat, located at anterior third of sides of head. Antennal scape slightly bent at base, thickened at apex, extending half the distance to occipital corners. Funiculus short, the first joint three times as long as thick; joints 2–8 as broad as long; club as long as the rest of the funiculus with the first two joints subequal, apical joint longer than the two preceding, connate. Pronotum and mesonotum in profile rounded, the sides of the former extended at the sides

in the form of a blunt cone. Promesonotal suture basally discernible. Epinotum at base strongly, broadly impressed for its entire length, the spines short, triangular and erect. Petiole thick, the node as deep as thick, from above one and a half times as long as broad; postpetiole from above transverse, narrowly rounded at sides. Gaster oval, short. Legs moderately long.

Sublucid. Mandibles shining, with sparse fine punctures at base. Front of head and cheeks with strong parallel striae, which become confused and disappear toward the vertex, where they are replaced by dense granulose punctation; this granulation extends forward, outward from the frontal carinae to the cheeks. Clypeus strongly, but more sparsely striate and shining. On the front and cheeks the spaces between the striae are smooth and shining; the occiput is very shining. Thorax and epinotum granulosely punctate. Node of petiole and postpetiole and base of first gastric segment with sparse, more shallow punctures; rest of gaster smooth and shining.

Head, thorax, and abdomen with long hairs, which are most abundant on the gaster. Sides of head in front sparsely pilose; antennae and legs with semierect hairs.

Worker. Length 1.5 mm.

Head, excluding mandibles, a little longer than broad, with slightly convex sides, broadly rounded occipital corners, and very slightly, narrowly concave border. Mandibles long, slender, the blades minutely denticulate. Clypeus convex, the anterior border rounded. Frontal carinae short, parallel. Antennal scapes surpassing the occipital corners by about one sixth of their length. Eyes large and convex, located at middle of sides of head. Thorax in profile rather low, evenly rounded. Promesonotal suture not discernible. Mesoëpinotal suture deeply impressed. Epinotum with equal base and declivity, the former depressed; spines very short, triangular. Petiole and postpetiole similar to those of worker.

Head, thorax, and epinotum subopaque; coarsely, densely granulose; cheeks with a few coarse striae. Petiolar node punctate; postpetiole and gaster smooth and shining. Head and body with sparse, fine hairs.

Color testaceous.

Female. Length 4 mm.

Head, excluding mandibles a little longer than broad, slightly narrowed in front, with feebly convex sides, shallowly excavated border. Mandibles and clypeus as in soldier. Antennal scapes extending three fourths the distance to occipital corners. Eyes large

and convex, situated at anterior third of head. Ocelli large, arranged in a triangle. Epinotal spines shorter than in the soldier. The rest similar to the soldier, with the usual sexual differences.

Sculpture of head similar to that of soldier, except that the coarse striae extend onto the vertex and occiput. Thorax smooth and shining. Epinotum transversely striate. Nodes and a space at the base of the first gastric segment granulously punctate. Pilosity as in the soldier.

Color dark fuscous, cheeks and clypeus lighter. Antennae and legs testaceous. Wings strongly infuscated; veins and stigma fuscous.

Described from several workers and a single female collected at Madeira-Mamoré Camp 39. The color of the soldier is striking. The head is rich reddish brown, darker on the vertex and front and lighter on the cheeks and clypeus. The mandibles are a rich red wine-color. The thorax and epinotum are dark fuscous, the gaster is similarly colored, but with the first segment lighter basally. This species approaches *P. susannae* Forel from which it differs in the much longer and differently sculptured head, the feeble promesonotal impression, and in color.

83. *Pheidole* (*Pheidole*) *triconstricta* Forel var. *laidlowi*, var. nov.

Soldier. Length 3.5 mm.

Head, excluding the mandibles, a little longer than broad, slightly broader in front than behind; posterior corners rounded; occipital margin rather deeply impressed; occiput at middle with a deep impression which extends to clypeus, becoming shallow anteriorly. Frontal carinae more than half the length of the scape, sharply defined. Eyes at sides of the anterior third of head. Mandibles convex, bidentate, the teeth thick and subequal. Clypeus trapezoidal, flattened, truncate in front and behind, with a narrow median impression from middle of front extending two thirds the distance to base. Frontal carinae diverging behind. Antennal scapes reaching three fourths the distance to occiput. Antennal club a little shorter than the rest of the funiculus, funicular joints 2–7 broader than long. Prothorax rounded above, sides a little in front of middle drawn out angulately. Promesonotal impression distinct. Mesonotum seen from above trapezoidal, narrowed in front, deeply, transversely constricted at middle, the posterior portion elevated into a ridge. Mesoëpinotal constriction deep and broad. Base of epinotum as long as declivity,

deeply concave; on either side with a high ridge which terminates in an acute, erect spine, about two thirds as long as the base. Petiole twice the length of postpetiole, the node broader than long, with conical sides; seen from the side concave in front, higher than postpetiole. Postpetiole broader than long, the sides conical.

Gaster smaller than the head. Legs slender. Head and gaster shining, thorax and petiole subopaque. Mandibles very finely punctate. Head densely, minutely punctate. Thorax, petiole, and postpetiole with more dense punctures. Legs finely punctate, shining.

Thorax without hairs, head, petiole, and gaster with sparse, scattered erect hairs.

Color pale brownish yellow, mandibles dark ferruginous.

Worker. Length 2 mm.

Head, excluding the mandibles, a little longer than broad, with convex sides and evenly rounded posterior margin. Eyes at sides of head in front of middle. Mandibles with two very acute teeth. Antennal scapes extending one third their length beyond the occipital margin. Thorax similar to that of the soldier, but the prothorax more rounded at sides. Epinotum, petiole, and postpetiole similar to those of soldier. Gaster as large as head.

Head, legs, and gaster shining, the rest of the body opaque.

Pilosity and color like those of the soldier. The hairs are even sparser. Mandibles and border of clypeus darker.

Described from several soldiers and workers from Madeira-Mamoré R. R. Camp 37.

Differing from the typical form in the smaller size, and pale color. The antennal scapes of the soldier are proportionally longer, reaching three fourths the distance to corners of occiput.

Named after Dr. James Laidlow, of the medical corps of the Madeira-Mamoré Railroad.

84. *Pheidole* (*Pheidole*) *biconstricta* Mayr.

Manaos, Porto Velho, Abuná and Camps 39, 41, 43 Madeira-Mamoré R. R.

On the Rio Madeira this species was very common, nesting in or beneath rotten logs. The colonies are very populous.

85. *Pheidole* (*Pheidole*) *biconstricta* subsp. *bicolor* Emery.

Madeira-Mamoré R. R. Camp 39.

86. *Pheidole* (*Pheidole*) *biconstricta* subsp. *burtoni*, subsp. nov.

Plate **3**, fig. 24.

Soldier. Length 6 mm.

Head, excluding mandibles, a little longer than broad, much narrowed in front, with convex sides, narrowly rounded occipital corners and deeply and narrowly excised posterior border. Mandibles thick, the blade with five short, very blunt teeth and a large subapical tooth. Clypeus rather flat, feebly carinate; anterior border strongly excised at middle. Frontal area large, triangular, impressed. Frontal carinae a third as long as antennal scapes. Antennal scapes broadly rounded at base, somewhat thickened apically, extending less than half the distance from the eyes to posterior corners of head. Club as long as the remainder of funiculus; funicular joints 2–7 as long as broad. Eyes small, convex, located at sides of anterior third of head. Pronotum similar to that of *P. biconstricta*, but the corners are somewhat more angulate. Mesonotum slightly convex above, with feeble transverse impression posteriorly. Base of epinotum much less impressed than in *P. biconstricta*. Petiolar node and postpetiole broader than long; the latter conical at sides.

Subopaque, except the occipital corners, mandibles, and clypeus, which are shining. Mandibles strongly striate at base and regularly punctate throughout. Head coarsely shagreened, coarsely longitudinally rugose between the frontal carinae. Vertex and occiput with foveolate punctures. Thorax and abdomen shagreened, the gaster more shallowly than the rest. Legs finely punctate. Each of the foveolate punctures on the head bears a short, stiff, recumbent hair. Body, antennae, and legs throughout with long, stiff pile.

Head, posterior portion of pronotum, and epinotum piceous; mandibles and clypeus red, the rest castaneous, the gaster distinctly lighter than the other parts.

Described from a single soldier taken at Porto Velho. The sculpture of the head is very different from the other forms of *P. biconstricta* and the transverse mesothoracic impression is broader and more shallow.

87. *Pheidole* (*Pheidole*) *fallax* Mayr subsp. *emiliae* Forel.

Several soldiers and workers were taken at Manaos.

88. *Pheidole* (*Pheidole*) *fallax* subsp. *jelksii* Mayr.

Found at Abuná, Bolivia, and at Porto Velho, Brazil.

89. *Pheidole* (*Pheidole*) *fallax* subsp. *jelskii* var. *antillensis* Forel.

Several workers and soldiers from Pará and Abuná, Bolivia agree closely with West Indian specimens before me.

90. *Pheidole* (*Pheidole*) *impressa* Mayr.

Two soldiers of this curiously colored species were taken at Baixa Verde. Since the types were described from Baturité in Ceará, the species has not been recorded. My soldiers differ a little in color from those described by Mayr, but otherwise agree closely with his description. The head is ferruginous instead of ochre-yellow and the gaster black. It may be that the Baixa Verde specimens represent an undescribed color variety, but I think it more probable that those before Mayr were more immature and the color not fully developed.

91. *Pheidole* (*Pheidole*) *wallacei*, sp. nov.

Soldier. Length 6 mm.

Head, excluding mandibles, longer than broad, narrowed behind; sides slightly convex; occipital corners narrowly rounded, the border with a shallow, narrow incision. Mandibles large and stout, the apical tooth long; blade with a short, stout subapical tooth and several very small teeth. Clypeus depressed; anterior border distinctly concave at middle. Frontal carinae strong and thin at base, extending only slightly past the antennal pits. Frontal area strongly depressed. Antennal scapes slender, extending almost to occipital corners, moderately bent at base; funiculus long and very slender, the first joint somewhat swollen, joints 2–8 cylindrical, three times as long as broad; club very slender, a little more than half as long as the rest of funiculus, the joints about four times as long as broad, apical joint a little longer than the penultimate. Eyes small, convex, located at anterior third of head. Pronotum in profile evenly rounded; the sides slightly drawn out and rounded a little posterior to the middle. Mesonotum in profile angulate at middle, the anterior part flat, the posterior declivous. Base of epinotum much longer than the declivity,

flat anteriorly, narrowly impressed posteriorly; spines triangular, the width at base greater than the height. Petiolar node twice as broad as long, in profile triangular. Postpetiole one and a half times as broad as long, narrowly rounded at sides. Gaster short, oval. Legs very long and slender.

Head shining; cheeks and front with widely separated rugae, which extend only slightly posterior to the eyes; front and vertex with sparse, distinct punctures. Mandibles sublucid, very coarsely and sparsely punctured at base. Thorax, epinotum, petiole, and postpetiole with sparse interrupted transverse rugae; the spaces between the rugae shining. Gaster finely punctate, shining. Funiculus sparsely pubescent, head, body, antennae, and legs with long hairs.

Color ferruginous; anterior border of head and the mandibles brownish red. Pile golden yellow.

Worker. Length 5 mm.

Form very long and slender. Head, excluding mandibles, much longer than broad, strongly narrowed behind to form a distinct neck, the posterior border of which is broadly expanded and elevated. Mandibles long, acuminate at tip, with a long subapical tooth and several shorter teeth. Clypeus depressed in front, the border strongly concave at middle. Frontal carinae subparallel, extending to opposite the anterior border of eyes. Eyes large and convex, situated at sides of front, anterior to the middle of head. Antennae very long and slender, the scapes about twice as long as the head including the neck; funicular joints similar to those of worker. Pronotum longer than broad, strongly narrowed in front; broadest behind middle; the pleurae extended behind into small elongate tubercles. Promesonotal suture strongly impressed. Mesonotum longer than broad, little convex. Mesoëpinotal impression broad and deep. Base of epinotum distinctly longer than the declivity, rounded above; spines very short, triangular, erect, located closer together than their distance from the sides. Petiolar node one and a half times as long as broad, triangular in profile. Postpetiole longer than broad, with rounded sides. Gaster oval. Legs very long and slender.

Sublucid. Cheeks with distinct, widely separated rugae. Front and vertex sparsely punctate. Mandibles sublucid, finely punctate. Pronotum in front with very sparse, transverse rugae, the rest of thorax and the abdomen finely punctate. Pile similar to that of soldier, but more sparse.

Color light ferruginous, anterior border of head, the mandibles, and the antennal club darker.

Described from several workers and soldiers, Madeira-Mamoré Camps 39 and 46. This very distinct and striking species is related to *P. bergi* Mayr and *P. oxyops* Forel, but is quite distinct from either. From *P. bergi* the soldier differs in the much longer antennal scapes, the more slender club, the differently shaped epinotum, which in *P. bergi* is broadly depressed, and in the much smaller size of the epinotal spines. *Pheidole wallacei* is a larger and more slender species.

The structure of the worker's head, long drawn out behind, and the very slender thorax and epinotum, and the small size of the spines distinguish it from the worker of *P. bergi*. The worker of the latter species has the meso- and epinotum granulously punctate and subopaque instead of smooth and shining as in *P. wallacei*. The worker has extremely long legs. Those which I observed were on the ground and entering a hole beneath a tree, where the nest was probably located.

92. *Pheidole* (*Pheidole*) *opaca* Mayr.

Numerous workers, soldiers and females from Pará, Abuná, and Madeira-Mamoré Camp 39, where it occurred commonly in populous colonies beneath logs.

93. *Pheidole* (*Pheidole*) *fimbriata* Roger.

A single soldier of this characteristic species was found at Ceará-Mirim, and a female at Madeira-Mamoré Camp 39.

94. *Pheidole* (*Pheidole*) *flavens* Roger.

Natal, Ceará-Mirim, Independencia, and Pará.

95. *Pheidole* (*Pheidole*) *flavens* subsp. *exigua* Mayr.

Taken at Ceará-Mirim and Independencia.

96. *Pheidole* (*Pheidole*) *colobopsis*, sp. nov.

Plate 3, figs. 25, 26.

Female (deälated). Length 4 mm.

Head, excluding mandibles, a little longer than broad; broadest

in front, with nearly straight sides, concave occipital border and narrowly rounded corners; anterior corners right-angled. Vertex slightly rounded above, a little longer than the front. Front separated from vertex by a distinct angle, and forming with the mandibles a disc; very strongly impressed with a deeper, longitudinal groove at middle. Frontal area small, triangular, more deeply impressed than the front. Clypeus deeply impressed at middle; the anterior margin carinate at middle, broadly crenulate. Frontal carinae strong, extending sinuately to ends of antennal scapes. Mandibles very short and thick, the blade slightly concave, edentate. Antennae short, the scape extending a little more than half the distance to occipital corners, strongly geniculate at the angle which separates front from vertex, thickened distally. First funicular joint as long as the two succeeding joints, joints 2–8 as long as broad; joints 9–11 forming a club as long as remainder of funiculus. Eyes large, oval, flat, with distinct ommatidia; situated at sides in front of middle. Antennal fossae deep; extending to apex of scape. Ocelli distinct, the median much the largest, each situated in a foveole, the median of which is extended forward as a groove. Thorax rather flat above, sides rounded; mesothorax a little longer than broad; scutellum rounded behind. Epinotum with subequal base and declivity; the base strongly concave at middle, with elevated sides, which terminate in short thick, acuminate spines; surface of declivity concave, but less so than the base. Petiole elongate; the node transverse, in profile narrowed above, constricted behind. Postpetiole twice as broad as petiole, the sides produced into angles, rounded in front, constricted behind; in profile evenly convex above. Gaster oval, broad at apex.

Shining, with abundant silky pilosity, which is partly recumbent on gaster and erect on the other parts of body. Cheeks, front, and clypeus devoid of hairs. Vertex longitudinally, crenulately striolate, front and clypeus with striolae arranged in a concentric pattern. Mandibles with five transverse, diagonal carinae. Thorax, petiole, and postpetiole minutely punctate; postpetiole above with five short longitudinal carinae.

Color testaceous; mandibular blades and posterior margins of gastric segments darker. Pilosity yellow.

Described from a single female taken at Madeira-Mamoré Camp No. 41. It was beneath a log, in company with a colony of *Myrmicocrypta foreli*. This is the first known South American Pheidole belonging to the group of species which have the front of the head depressed and disc-like, somewhat similar to that of the major worker in Camponotus subgenus Colobopsis.

97. *Crematogaster* (*Crematogaster*) *stolli* Forel.

This very distinct species was abundant at all the localities visited along the Rio Madeira. The covered galleries that it constructs superficially resemble termite runways, but are built of fibrous material. They extend along tree trunks, often in an irregular spiral direction around the tree and branching to the limbs. The nest varies from hemispherical to broad and flat, up to five or six inches in width, though generally smaller. The brood-chambers are in deep cavities. The acrid secretion from the anal glands of *C. stolli* is much more pungent than that of any other Crematogaster which I have observed.

98. *Crematogaster* (*Crematogaster*) *stolli* subsp. *autruni*, subsp. nov.

Worker. Length 4.5 mm.

Head, excluding mandibles, a little broader than long, as broad in front as behind, with rounded sides, broadly rounded occipital corners; the occipital border nearly straight, but narrowly concave at middle. Clypeus about as broad as long, with slightly rounded surface and broadly rounded anterior border. Mandibles short and stout. Frontal carinae feeble, but distinct, extending to opposite the eyes, which are located at middle of sides of head. Eyes small and flat. Antennae short and stout, the scapes arcuate, much thickened distally, extending about two thirds the distance to occipital corners. First funicular joint as long as the two succeeding joints taken together; joints 2–7 as long as broad. Pro- and mesonotum together as broad as long, evenly rounded above and at sides. Epinotum with subequal base and declivity, the base rounded in profile, the surface of base concave. Spines moderately long and stout. Petiole in profile about twice as long as broad; from above, flattened and two thirds as broad as long. Postpetiole elongate, rounded. Legs stout. Gaster of medium length, triangular.

Body sublucid. Head in front with sparse, fine punctation; cheeks, sides of head and a space parallel to the frontal carinae densely striolate. Mandibles rugosely striolate, with a few fine recumbent white hairs. Antennae punctate, the funiculus with considerable fine, recumbent pile. Promesonotum finely rugulosely punctate, with a few very fine hairs. Epinotum and mesothoracic pleurae

coarsely striolate. Petiole and postpetiole rugosely punctate. Gaster subopaque, densely punctate, with a few erect black hairs.

Color black, except the head, which is somewhat reddish.

Described from six workers taken near Manaos. This form, which is named after Don Antonio Autrun, our genial host at Kete Purangi, differs from *C. stolli* in the shorter antennal scapes and in sculpture and color, besides being smaller. The epinotal spines are shorter and thicker and the head and thorax lack the long, erect hairs of *C. stolli*. I am in doubt whether *C. autruni* should not be considered as specifically distinct rather than as a subspecies.

99. *Crematogaster* (*Crematogaster*) *heathi*, sp. nov.

Plate 3, fig. 27.

Worker. Length 2.5 mm.

Head about as broad as long, with slightly convex sides and broadly rounded occipital corners; occiput faintly excavated. Eyes small, little convex, located at sides of head slightly posterior to middle. Mandibles short and stout, the blade strongly concave. Antennal scape not reaching the occipital corners; funicular joints, except those of the club, subglobose, as broad as long. Clypeus quadrate, as broad as long, the anterior border broadly rounded. Prothorax subglobose; pronotum as broad as long, with narrowly rounded sides, so that the disc is transversely oval, broadly rounded above. Epinotum with a very short base, which is narrowly rounded, giving in profile the appearance of a tubercle; the declivity is three times as long as the base, with a broad, flat surface, on either side of which is a strong spine curving outward and upward. Petiole flattened above, not quite so broad as long, with straight posterior margin; postpetiole subglobular. Gaster short and broad, triangular.

Head shining, minutely punctate throughout, the front with sparse, coarse punctures. Thorax, petiole, postpetiole, and legs sublucid. Gaster subopaque, densely punctate. Head and thorax, petiole and postpetiole in front sparsely pilose, the pile fine and recumbent. Antennæ, legs, and abdomen with erect pilosity.

Color red, except the gaster, which is black, and the legs, which are somewhat infuscated. Pile and pubescence yellowish.

Described from a large number of workers taken from twigs at Independencia. This species is related to *C. brevispinosa* from which it differs in the structure of the epinotum and in the absence of teeth

on the mandibular blades. In living specimens the black color of the gaster is in vivid contrast to the red of the other parts.

100. *Crematogaster* (*Crematogaster*) *brevispinosa* Mayr.

Several colonies of this well-marked species were taken at Itacoatiara and Abuná, Bolivia.

101. *Crematogaster* (*Crematogaster*) *brevispinosa* subsp. *rochai* Forel.

This is common at Natal and Baixa Verde, where numerous colonies were found. The workers agree closely with cotypes from Ceará.

102. *Crematogaster* (*Crematogaster*) *victima* F. Smith.

Many colonies were found in hollow twigs at Natal, Baixa Verde, Independencia, Pará, and Madeira-Mamoré Camp 39.

103. *Crematogaster* (*Crematogaster*) *sulcata* Mayr.

Abuná, Rio Madeira.

104. *Crematogaster* (*Crematogaster*) *limata* F. Smith.

Common at Manaos and Porto Velho. A colony at the latter locality was nesting in a leguminaceous pod.

105. *Crematogaster* (*Crematogaster*) *brasiliensis* Mayr.

Manaos and Porto Velho.

106. *Crematogaster* (*Crematogaster*) *longispinosa* Emery.

Many workers were taken at Abuná.

107. *Crematogaster* (*Crematogaster*) *acuta* (Fabricius).

Many workers are in the collection from Madeira-Mamoré Camp 39.

108. *Monomorium* (*Mitara*) *subterraneum*, sp. nov.

Plate 4, figs. 29, 30.

Worker. (Plate 4, figs. 29, 30). Length 3.5 mm. to 5 mm.

Head, excluding mandibles, as long as broad, nearly as broad in front as behind, with convex sides and feebly concave occipital border. Eyes small, located at sides of head, a little posterior to the middle. Clypeus very convex, unarmed, the anterior border somewhat concave. Frontal carinae short, straight. Antennae 11-jointed; scapes extending a little past the occipital corners of head; first funicular joint longer than broad and nearly twice the length of the second, which is a little longer than broad; joints 3–7 as broad as long; joints 8–10 forming an elongate club, almost as long as the rest of funiculus, the apical joint of which is longer than the two preceding together. Mandibles rather thick, the blade with five strong teeth. Pronotum transverse, convex above and at sides, broadest a little behind the middle. Promesonotal suture barely perceptible; mesoëpinotal impression strong. Epinotum in profile evenly rounded; the sides very feebly margined. Petiole slender, the node in profile deeper than thick, rounded above, convex at the anterior, flat at the posterior surfaces. Postpetiole transverse, subglobose. Gaster as long as thorax and epinotum, broadly oval. Legs long and slender.

Sublucid. Mandibles, sides of clypeus, and frontal carinae coarsely striate longitudinally; cheeks with strong concentric striae, which terminate at the carinae, the vertex with sparse irregular rugae, the rest of head and the thorax densely punctulate. Epinotum transversely, and the posterior surfaces of the petiolar and postpetiolar nodes longitudinally carinulate. Gaster shining, sparsely punctate. Apical half of funiculus pubescent; the rest without pubescence but abundantly pilose, the pile stiff and erect.

Color testaceous, with a fuscous blotch on the front and vertex.

Described from a number of workers from Madeira-Mamoré Camp 39. These were in the ground, beneath the base of a recently uprooted palm, about three feet below the surface.

In a recent paper (Ann. Soc. ent. Belg. 1913, **57**, p. 261) Emery has divided those species of Monomorium which have eleven-jointed antennae into three subgenera. Of these, *M. subterraneum* must be placed in Mitara, which hitherto has contained only African, Asiatic, and Australian species. The species in this subgenus have the clypeus entirely without denticles or carinae, the eyes developed, and

the epinotum unarmed. *Monomorium subterraneum* is very different from any other of the American Monomoriums on account of these characters, and also because it is an unusually large species, with considerable variation in size between the largest and smallest workers. The small eyes, the abundant stiff hairs with which the body is covered, and the color, as well as the location in which the colony was found, indicate that this species is hypogaeic in habit.

109. *Megalomyrmex bituberculatus* Forel.

Many workers which agree closely with specimens from the Rio Purus, received from Forel, were taken at Manaos, Porto Velho, and Madeira-Mamoré Camps 39 and 41. This form, which is confined to the upper Amazonian region, attends Membracidae and the workers were generally found in company with these on shrubs in the deep forest. The nest is subterranean, the entrance nearly always at the base of a tree. The living insect is slow in its movements.

110. *Megalomyrmex wallacei*, sp. nov.

Plate **3**, fig. 28.

Worker. (Plate **3**, figs. 28). Length 5 mm.

Head, excluding mandibles, one and a third times as long as broad, broadest at clypeus, strongly narrowed above eyes, with slightly convex sides and straight occipital border, the latter distinctly, though narrowly, margined. Clypeus long and narrow, not separated from frontal area, the sides extending to outer bases of mandibles; anterior border projecting and narrowly rounded at middle. Frontal carinae distinct, elevated at insertion of antennae, parallel, extending to opposite anterior border of eye. Mandibles long and acuminate, the blade with four pointed teeth. Eyes large and very convex, situated at sides of front of head, a little anterior to the middle. Antennae long and slender; extending about one third their length beyond the occipital corners. First funicular joint nearly twice as long as the second, joints 2–8 subequal, longer than broad, cylindrical, joints 9 and 10 subequal, each twice as long as the eighth and a little shorter than the apical. Thorax long and slender. Prothorax slightly rounded above, sides rounded. Promesonotal suture faint.

Mesonotum pyriform, flattened behind, with a feeble transverse impression at middle and a longitudinal impression in front, the sides slightly margined posteriorly. Epinotum in profile rather flat above; its base about twice as long as declivity, into which it passes at a broad rounded angle; surface of base broadly concave, that of declivity flat; base of declivity with broad, ear-shaped tubercles. Petiole one and a half times length of postpetiole, without anteroventral tooth; the node in profile as deep as broad, concave in front, rounded behind, with a constriction near apex. Postpetiole broader than petiolar node, rounded above, the anterior surface nearly straight; anteroventral border angulate in front, but without distinct tubercle or tooth. Legs long and slender.

Gaster shining, sparsely, regularly punctate; rest of body and the legs subopaque. Head and thorax rugulosely punctulate, a median, longitudinal surface on the front less so and more shining than the rest; front of head between frontal carinae and eye concentrically striolate. Mandibles shining, coarsely striate. Epinotum and petiolar node transversely striolate; postpetiole rugulose like the front of head. Body and legs everywhere with abundant erect hairs. Mandibles, funiculus, and antennal scapes with semierect hairs, last four funicular joints pubescent.

Color light ferruginous, pile and pubescence yellow.

Female (deälated). Length 6.5 mm.

Closely resembling the worker. The white ocelli are small, but distinct. The smooth surface on the front is shorter but more distinctly shining than in the worker.

Described from a single female and several workers found at Porto Velho. This species is near *M. iheringi* Forel, from which it differs in its larger size, the head more constricted behind, in the much larger size of the eye, and in the subopacity of the tegument, which in *M. iheringi* is shining.

111. *Tranopelta gilva* Mayr. var. *albida*, var. nov.

Several workers of a small variety of *Tranopelta gilva* Mayr were taken at Camp 39, Madeira-Mamoré R. R. These differ from var. *brunnea* Forel, the only form of which the worker is known, in the smaller size (length 1.5 mm.) and in the uniformly pale color which in the series before me is almost white, with a faint tinge of yellow.

112. *Solenopsis picea* Emery var. *subadpressa* Forel.

This variety, somewhat larger than the typical Costa Rican form, was described by Forel from specimens collected by Sr. Diaz da Rocha at Ceará. Specimens which agree well with cotypes in the Wheeler collection were taken at Porto Velho, Abuná, and Madeira-Mamoré R. R. Co. Camp 39.

113. *Solenopsis globularia* (F. Smith).

One colony with numerous workers and females was found at Natal. The large size and globular shape of the postpetiole distinguish this from related species.

114. *Solenopsis subtilis* Emery.

One small colony was taken at Manaos.

115. *Solenopsis geminata* (Fabricius).

Colonies of the typical form of this widely distributed species were found at Natal, Independencia, Baixa Verde, Itacoatiara, Manaos, and Porto Velho.

116. *Solenopsis geminata* (Fabricius) subsp. *medusa*, subsp. nov.

Plate 4, fig. 31.

In a number of colonies from Ceará-Mirim and the Maránguapé mountains the largest headed of the soldiers differ from those of typical *S. geminata* in having the sides of head at the anterior corners broadly expanded, as shown in Plate 4, fig. 31.

I can detect no character in the smaller soldiers and workers that will distinguish them from the same phases of *S. geminata*, but the difference between the largest soldiers is striking and constant and seems to be of subspecific value. It is probably a local race, limited to the east coastal region of Brazil.

117. *Solenopsis saevissima* (F. Smith).

Very abundant at Pará, Itacoatiara, and Manaos in Brazil and at Abuná, Bolivia. There can be no doubt that this species is the one

described by Smith from specimens sent to him by Bates and of which the latter has given an interesting account in his Naturalist on the River Amazons. It is the common fire ant ("formigo do fogo" of the Brazilians) of the Amazonian region, where it occurs generally in cultivated districts and is a bad pest. The colonies are large and numerous and the individuals highly aggressive, and, because of their numbers and painful sting, very formidable.

Smith's name has long been included with the synonyms of *S. geminata*, and *S. saevissima* was redescribed as *S. pylades* by Forel, but from field observations, compared with the notes of Bates and Smith and compared with specimens of *S. pylades* determined by Forel I am certain that the name given by the former author applies to this species.

118. *Leptothorax* (*Goniothorax*) *echinatinodis* Forel subsp. *spininodis* Mayr.

Plate **4**, fig. 36.

Many workers and males from colonies which were nesting in twigs at Independencia, Ceará-Mirim, and Manaos agree closely with Mayr's description, except that in the entire series before me the tips of the femora are distinctly infuscated.

The types of this species were taken from an egg-case of a species of Mantis from a doubtful locality.

119. *Tetramorium* (*Tetrogmus*) *simillimum* F. Smith.

Several workers of this tropicopolitan species were taken at Manaos.

120. *Wasmannia auropunctata* (Roger).

This is one of the most widely spread Neotropical ants. It was taken in Brazil at Natal, Independencia, Itacoatiara, Manaos, Porto Velho, Madeira-Mamoré Camps 39 and 41, and at Abuná, Bolivia.

121. *Cryptocerus* (*Cephalotes*) *atratus* (Linné).

Common throughout northern Brazil. Taken by the Expedition at Pará, Manaos, Itacoatiara, and on the upper Rio Madeira. The species nests generally in hollowed branches of high trees, though one

nest was in the hollowed trunk of a small tree. It is omnivorous in habit, frequenting garbage and eating even carrion. Some dead macaws which I placed in the woods as bait for carrion-feeding insects were continually covered by *C. atratus*, to the exclusion of other insects. It is diurnal, and a striking form as it walks slowly about on tree trunks and logs. The hard spiny armor is sufficient to protect it from any ordinary enemy.

122. *Cryptocerus* (*Cephalotes*) *oculatus* (Spinola).

One colony from Pará.

123. *Cryptocerus* (*Zacryptocerus*) *clypeatus* (Fabricius).

This species was very common at all places along the Rio Madeira, and at Itacoatiara and Santarem. A large colony was found nesting in a hollow parasitic vine.

124. *Cryptocerus* (*Cryptocerus*) *umbraculatus* (Fabricius).

A colony found at Abuná, Rio Madeira was nesting in a hollow branch near the top of a recently felled tree.

125. *Cryptocerus* (*Cryptocerus*) *inaequalis*, sp. nov.

Worker. Length 5.25 mm.

Head broader than long, broadest behind the eyes; narrowed in front. Posterior margin straight, the angles projecting as lamellae, and broadly concave at apex. Sides and anterior corners of head evenly rounded. Anterior margin of clypeus deeply concave. Pro- and mesothorax together as broad as long; prothorax angulate at the anterior corners and with a pair of flat triangular teeth at posterior half of margin. Sides of mesothorax with a short slender spine at middle. Epinotum more than twice as broad as long, with two broad teeth at sides. Petiole and postpetiole subequal in width. Petiole with long, slender, backward curving spines. Spines of the postpetiole short and broad, projecting forward. Gaster broadly cordiform, very convex above; anterior third of sides broadly margined; excised at middle of anterior border.

Subopaque. Sparsely, foveolately punctate above, except the gas-

ter, which is finely and densely punctate. Legs foveolately punctate. Each puncture bearing a glistening scale-like hair.

Color black, with the marginate portions of the head and gaster yellow, and the tibiae ferruginous.

Described from four workers from Abuná and Madeira-Mamoré Camp 41.

The very long, slender, and curved spines of the petiole, compared with those of the postpetiole, and the lamellate occipital corners, with the concave apices are characteristic of this species. It is related to *C. spinosus* but differs in the form of the spines, and the absence of pile on the dorsum.

126. *Cryptocerus* (*Cryptocerus*) *spinosus* Mayr.

One colony found at Porto Velho, Rio Madeira.

127. *Cryptocerus* (*Cryptocerus*) *pusillus* Klug.

Widely distributed throughout Brazil. Numerous specimens were taken at Ceará, running along the wires of a fence, in the posts of which they were nesting. At Manaos a colony was taken from a hollow twig.

128. *Cryptocerus* (*Cryptocerus*) *minutus* (Fabricius).

Nesting in twigs at Natal, Manaos, Itacoatiara, and Porto Velho.

129. *Cryptocerus* (*Cryptocerus*) *depressus* Klug.

This was the commonest species of the genus at Manaos.

130. *Cryptocerus* (*Cryptocerus*) *maculatus* F. Smith.

A few specimens were taken at Natal, and a colony was found in a hollow twig on a cajú tree at Abuná, Bolivia.

131. *Cryptocerus* (*Cryptocerus*) *multispinus* Emery.

A single worker from Abuná.

132. *Cryptocerus* (*Cryptocerus*) *cordatus* F. Smith.

A small colony from Porto Velho.

133. *Cryptocerus* (*Cryptocerus*) *complanatus* Guérin.

Plate **4**, fig. 35.

A colony of *C. complanatus*, originally described from Cayenne, was taken from a twig at Itacoatiara. The species belongs to the group containing *C. cordatus*, *C. spinosus*, and *C. inaequalis*.

Worker. Length 5 mm.

The head is as broad as long, margin of occiput only slightly concave, the corners broadly angulate, without spines; front narrower than occiput; sides in front of eyes convex. Thorax longer than broad. Sides of prothorax narrowly margined, nearly straight; anterior corners angulate. Mesothorax with short spine at sides. Epinotum three times as broad as long, with a blunt spine at middle and a longer one at apical corners. Spines of petiole and postpetiole curved backward, those of the petiole the largest. Abdomen cordate, without dorsal impression at base.

Body subopaque, coarsely punctate, each puncture with a short silvery hair.

Color black throughout.

Soldier. (Plate **4**, fig. 35). Length 6 mm.

The body is less hairy and more shining than in the worker. The transverse carina between the pro- and mesothorax is prominent at sides and more feeble on disc. The angles at anterior corners of prothorax are acute. Mesothorax with short, blunt spines at sides. Epinotum without spine at middle; the corners with a short, pointed spine. Spines of petiole and postpetiole similar to those of worker, but stouter.

Color black.

The worker agrees in outline with the Peruvian specimen figured by Emery (Bull. Soc. ent. Ital. 22, 1890, **22**, p. 75, pl. 9, fig. 6). The outline of the soldier is shown in Plate **4**, fig. 35.

134. *Cryptocerus* (*Cryptocerus*) *pilosus* Emery var. *fiebrigi* Forel.

Several workers and soldiers from Natal agree closely with the description and with cotypes of this variety received from Dr. Forel. This very distinct species has not been hitherto recorded from Brazil, but undoubtedly is widely distributed along the coast.

135. *Daceton armigerum* (Latreille).

There were several colonies of this species in the grounds of the Zoölogical Garden at Pará, where workers were often seen on the fences and trees. At Itacoatiara I found a very large colony nesting in a hollow standing tree.

136. *Acanthognathus ocellatus* Mayr.

Plate 5, fig. 39.

Female. (Plate 5, fig. 35). Length 3.5 mm.

Head cordate; excluding mandibles, twice as long as broad, with convex sides and deeply excised occiput. Eyes large, convex, situated at middle of sides of head. Ocelli small, convex, white in color. Clypeus longer than broad, its anterior border truncate. Antennae slender and short; the scape not attaining the occipital corners, bent and slightly thickened distally; first funicular joint two and a half times as long as broad; joints 3–9 scarcely longer than broad; last two much longer than broad, the apical nearly twice the length of penultimate. Mandibles nearly as long as head, slender, straight; apex with two long subequal teeth and a shorter tooth. On the inner side near the base is a curved process, which extends upward a little past the base. This is bidentate at apex. Pronotum very narrow; in profile flat. Mesonotum evenly rounded above and at sides. Scutellum rounded. Epinotum with base and declivity subequal in length, the angle bearing a pair of stout, acute spines. Petiole elongate, slender, the node globular. Postpetiole subglobose, about as large as the petiolar node. Gaster short and thick.

Head in front somewhat shining; genae and occiput smooth and shining. Mandibles finely punctate. Antennae and thorax subopaque, the latter coarsely, rugosely punctate. Scutellum with five feeble longitudinal carinae. Petiole, postpetiole, gaster, and legs finely punctate, shining.

Front of head and occiput, thorax, petiole, postpetiole, gaster, legs, and antennal scapes pilose.

Color ferruginous; the front of head, thorax, and gaster darkest, legs lightest.

Described from one female which was found with a solitary worker beneath a board on the ground at Pará.

137. *Strumigenys smithi* Forel.

A single worker from Pará is in the collection.

138. *Strumigenys schulzi* Emery.

A single female and several workers were taken at Pará, the type-locality.

139. *Atta cephalotes* (Linné).

Common throughout the forest regions, in enormous colonies. Numerous specimens were taken at Porto Velho, Abuná, and Madeira-Mamoré Camp 41.

140. *Atta sexdens* (Linné).

Many specimens were collected at Natal, Ceará, Independencia, Baixa Verde, Ceará-Mirim, Manaos, and Porto Velho.

This ant (the "sauba" of the Brazilians) ranges throughout the tropical portions of South America, and is by far the most important economically of all ants. It strips many cultivated plants of their leaves, is especially attracted to citrus species. It takes also dried vegetable matter, in particular farina, the staple food of Brazil. At Independencia, back of our house was a large pile of kitchen refuse, and this was visited nightly by hordes of workers, which collected particles of farina, bread, and other vegetable material.

All sizes of workers forage for leaves, generally at night, but also in late afternoons or on cloudy days. The smaller workers of this and the preceding species often ride upon a portion of a leaf which is being carried by a large one and this has given rise to the native belief that the larger workers are blind and are guided by the smaller ones.

141. *Acromyrmex* (*Moellerius*) *landolti* Forel.

Common at Natal and Baixa Verde.

This species was described from a specimen from Colombia, and Forel has since recorded it from Bahia, and Emery from Venezuela. At Natal and Baixa Verde nests were very common. At the entrance is built a turret of grass, from one to six inches in height. Through

this run circular tunnels, which vary in number, from one to eight. From the entrance the tunnel runs perpendicularly to the first fungus-garden chamber. This is about three inches in diameter and from six inches to two feet below the surface. The colonies are rather small. Although on the watch for inquilinous insects I failed to find any spiders in the turrets, as reported by Emery (Ann. Soc. ent. France, 1888, ser. p. 66.) in nests at Caracas.

142. *Acromyrmex* (*Acromyrmex*) *coronata* (Fabricius).

Several colonies were found at Pará.

143. *Acromyrmex* (*Acromyrmex*) *aspersa* (F. Smith).

Common at Natal, Baixa Verde.

144. *Acromyrmex* (*Acromyrmex*) *octospinosa* (Reich).

Numerous workers were found at Itacoatiara.

145. *Acromyrmex* (*Acromyrmex*) *nigrosetosa* Forel.

One colony was found at Souza, near Pará.

146. *Acromyrmex* (*Acromyrmex*) *nigra* (F. Smith).

Several workers are in the collection from Itacoatiara.

147. *Acromyrmex* (*Acromyrmex*) *emiliae* Forel.

A few workers were found at Madeira-Mamoré Camp 39.

This large, opaque form is very distinct from the related species in having no tubercles on the epinotum.

148. *Trachymyrmex diversus*, sp. nov.

Worker. Length 4 mm.

Head, excluding mandibles, a little longer than broad, broader behind than in front, with convex sides, and pointed posterior corners; occipital margin slightly concave. Eyes convex, located in front of

the middle of the sides of head. Mandibles with two large apical teeth and several fine ones basally. Anterior border of clypeus broadly rounded. Lobes of frontal carinae large, flattened, subtriangular, the carinae extending back as strong, converging ridges nearly to the occipital corners of the head. Antennal scapes distinctly thickened apically, extending about one third their length past the occipital corners; funicular joints all distinctly longer than broad. Occipital angles with one large, double spine, and anterior to these several small conical tubercles. Preorbital carinae extending backward toward, but not reaching the occipital corners of the head. Vertex with distinct ridges, which converge posteriorly. Lateral spine of pronotum long and stout, the apex excised to form two blunt tips, the anterior of which is higher than the posterior. Median spines very short, conical. Inferior spine two thirds as long as lateral spines, stout, the apex broadly rounded. Mesonotum with two pairs of lateral, subequal, stout spines, about one third the length of the prothoracic spines, strongly denticulate. Mesoëpinotal constriction rather strongly impressed. Epinotum with subequal base and declivity, meeting at obtuse angle; with a pair of short, blunt spines a little in front of the middle of base; apical spines short and conical. Petiole from above about as broad as long, very abruptly narrowed anteriorly into a short petiole; node with a pair of stout spines. Postpetiole as broad as long, twice as broad as petiole; the posterior border distinctly margined, with a flattened impression anterior to margin and the lateral borders with three strong tubercles, the two anterior short and triangular, the one posterior longer and blunt.

Gaster suboblong, broadest behind the middle; first segment with prominent lateral ridge. Tubercles small, blunt, few in number. Legs long, rather slender, without tubercles.

Mandibles faintly shining, with a few hairs; remainder of body opaque and finely granular.

Hairs ferruginous, sparse, very short, and depressed, except on the ventral surface of gaster, where they are longer and suberect.

Color ferruginous, the antennae and carinae of front and vertex darker.

Described from workers taken on the trunk of a palm at Abuná, Rio Madeira.

Most closely related to *T. oetkeri* Forel from Sao Paulo, but differing in the smaller size of the anterior pronotal spines, which in T. *oetkeri* are much longer than the posterior pair.

149. *Apterostigma branneri*, sp. nov.

Plate 5, fig. 37.

Worker. Length 5 mm.

Near *A. calverti* Wheeler. Head, excluding mandibles one and three fourth times as long as broad, with nearly straight sides, as broad in front as behind. Posterior portion convex, behind contracted into a rather short neck, the sides of which are straight, the posterior angles somewhat prolonged and the border between them truncate. Eyes convex, located a little behind the middle of sides of head. Clypeus twice as long as broad, with rounded anterior border. Mandibles with seven subequal teeth. Frontal carinae in front strongly lobed, behind these becoming very feeble, the posterior portion shorter than the lobes. Antennal scape extending nearly one half its length past the occipital corners, first funicular joint nearly as long as the three succeeding joints together; joints 2–9 broader than long. Thorax elongate. Pronotum with a moderately strong anterior border, which is slightly reflexed. Mesonotum with a pair of subparallel longitudinal ridges. Epinotum with similar ridges extending along base, and to base of declivity. In profile the declivity of the epinotum is nearly straight and about as long as the slightly convex base; the angle between the two surfaces rounded. Petiole from above less than twice as long as broad, sides convex, evenly narrowed anteriorly to the point of insertion. In profile the node is rounded, more than half as high as the length of the petiole. Postpetiole slightly broader than long, broadest a little behind the middle, the sides evenly rounded; posterior border very slightly convex. Gaster elliptical, without a longitudinal ridge on each side. Legs long, rather stout.

Mandibles feebly shining, finely longitudinally striate and sparsely punctate. Funiculus of antennae slightly shining, the rest opaque, very densely punctate.

Hairs abundant, long, suberect, dark at base, lighter towards apex. Pubescence very short.

Color dark brown, funiculus lighter.

Female. Length 5.25 mm.

Closely resembling the worker. The eyes are larger. Mesothorax without longitudinal ridges. Scutellum with two broad, blunt teeth. Base and declivity of epinotum equal, meeting to form an obtuse angle; base with faint parallel ridges. Wings opaque, dark fuscous,

with an elongate black spot between branches of cubital vein. Rest as in the worker.

Male. Length 5 mm.

Head, excluding mandibles about one and one third times as long as broad, rounded at sides, behind more suddenly constricted than in the worker and female. Eyes and ocelli large, very convex. First joint of funiculus one third as long as second; second joint one and one fourth times as long as third; joints 3–11 subequal, two and one half times as long as broad. Prothorax in front constricted; seen in profile depressed; broadly margined. Mesothorax rounded, without longitudinal ridges. Scutellum with broad, flat teeth, as in female. Epinotum, petiole, postpetiole, and gaster similar to these parts in the female.

Pilosity abundant, black, suberect on the head and body, more depressed on the legs.

Wings. Length 4 mm.; fuscous, clouded with darker spots.

Color as in worker and female.

Described from specimens taken from two colonies at Abuná and Madeira-Mamoré R. R. Camp 39. *Apterostigma branneri* approaches most closely *A. calverti* Wheeler from Costa Rica, but *A. branneri* has the head distinctly longer, the pronotum less declivous in front, and without the deep impression posterior to the margin, and it lacks the distinct ridge on the propleurae; the angle between the base and declivity of the epinotum is much more obtuse. Seen in profile, the slope of the epinotal declivity is more gradual. The size of the worker of *A. calverti* is smaller (3.5–4 mm.).

150. *Myrmicocrypta foreli*, sp. nov.

Plate **4**, fig. 32–34.

Worker. Length 3.25 mm.

Head, excluding mandibles, about one fourth longer than broad, a little longer behind than in front, with slightly convex sides and concave occipital border, the occipital corners drawn out into thick blunt spines. Front broad and flat. Clypeus with broadly rounded anterior border. Frontal carinae somewhat elevated at base of antennal scape, anteriorly extending outward, almost attaining outer corners of the clypeus; posteriorly very slightly diverging towards occipital border, becoming much weaker at a little less than half the distance from base of scape to occiput. Antennal scapes curved,

thickened at tips, extending one fourth their length beyond the occipital corners. Joints 3–8 of funiculus a little broader than long, gradually increasing in length towards apex; the basal joint of club one half as long as the terminal. Eyes small, located at the middle of sides of head. Mandibles long and rather slender with about seven short teeth on the blade, the penultimate and apical larger than the others. Pronotum concave at middle of front; on the side anteriorly with a sharp, minutely tuberculated crest; the median surface posteriorly with a pair of short, parallel tuberculated ridges, half as far apart as those lateral and anterior, extending half the length of the pronotum with a depression between them and the lateral margin; inferior spine short and acute. Promesonotal impression strong. Mesonotum lower than the pronotum but higher than the epinotum; at sides with a bidentate crest. Epinotum with subequal base and declivity, the latter very abrupt. Base margined with tuberculate ridges, which terminate in spines, which are stout, acute and about half as long as the declivity. Petiole elongate; the node globular, shorter than the distance to point of insertion. Postpetiole twice as broad as petiole, broader than long, sides evenly convex, posterior border truncate. Gaster elongate, broadest in front of apex of first segment. Legs long and stout.

Body and legs subopaque, except the gaster, the first segment of which is shining. Head with very small tubercles arranged in more or less circular patterns on the front. Mandibles longitudinally striate, sublucid. Body everywhere finely granular, with minute tubercles, which are coarser on the petiole, postpetiole, femora, and tibiae, and more scattered on the gaster.

Body, antennae, and legs with thick, short, curved, recumbent, glistening hairs.

Color light ferruginous, the blades of the mandibles darker.

Female (deälated). Length 4 mm.

Head similar to that of worker. Pronotum transverse, flattened above, the sides thinly margined, the margins projecting anteriorly as blunt lateral teeth. Mesonotum slightly rounded above, with a longitudinal pair of denticulated crests at sides and middle and between these a simple carina. The posterior border of scutellum extending into a pair of blunt spines. Epinotum with two long, strong spines at angle of base and declivity, which are equal. The rest similar to worker.

The color is somewhat darker, being light reddish brown.

Described from one female and several workers collected at Madeira-

Mamoré Camp 41. The colony was under a log, about three inches beneath the surface of the earth. A short perpendicular passage led to a single chamber in which was the small fungus garden.

151. *Cyphomyrmex rimosus* (Spinola).

Natal, Baixa Verde, Pará, Manaos, Abuná, Porto Velho, and Abuná, Bolivia.

Occurs in small colonies, beneath stones or in rotten wood. The death feigning instinct is strongly developed and the insect rolls up and remains inert for some time when touched.

DOLICHODERINAE.

152. *Dolichoderus* (*Dolichoderus*) *decollatus* (F. Smith).

This species occurs commonly throughout the greater part of tropical South America. A large series of workers, collected at Itacoatiara, Porto Velho, and Madeira-Mamoré Camp 39, shows a great deal of variation in color. Some have the head and thorax brownish red, in others these parts are entirely black. These forms are connected, by gradations.

Most of the workers that I observed were on the trunks of high trees. They are slow in motion, and have a habit of remaining motionless for many minutes at a time. When alarmed they drop to the ground.

153. *Dolichoderus* (*Dolichoderus*) *imbecillus*, sp. nov.

Plate 2, fig. 18.

Worker. (Plate 2, fig. 18). Length 10 mm.

Near *D. atellaboides.* Head, excluding mandibles and the neck, longer than broad, with convex sides. Occiput prolonged into a neck which in profile is nearly twice as long as thick and moderately reflexed at the posterior border. Mandibles slender, the blade with ten minute teeth and two larger coarser ones apically. Pronotum as broad as long, rounded above and at sides. Mesothorax similar to that of *D. atellaboides,* long and slender; in front with a small, rounded, elevated portion, on each side of which is a strong impression, extending backward and converging and terminating in

tubercles at the posterior third. Epinotum elevated, in profile a little longer than deep, triangular; apex armed with a pair of strong, slightly curved spines; base and declivity subequal in length, the surface of the former convex, of the latter flat. Petiolar node in profile one and a fourth times thicker than long; from above twice as broad as long; the posterior surface sloping.

Sculpture similar to that of *D. atellaboides*, the head, pronotum, and epinotum sublucid; petiolar node very coarsely and densely rugose; mesothorax shining, less rugose; mesopleurae transversely striate.

Gaster finely punctate and shining. Mandibles punctate. The body, antennal scapes, and legs with rather abundant, erect, stiff hairs.

Color dark reddish brown to black, gaster black, legs lighter. Pile of body and legs grey to white, of antennal scapes, black.

Described from eleven workers taken at Manaos. They were feeding on the exudation of a small shrub along a trail in the forest.

This species is closely related to *D. atellaboides*, but differs in its smaller size and more slender form, the longer neck and petiolar node and the shining gaster. *Dolichoderus rosenbergi* Forel from Ecuador, also has the gaster shining, but the first antennal joint in four times as long as broad (in *D. imbicellus* it is less) and the size is larger (13 mm.).

154. *Dolichoderus* (*Dolichoderus*) *atellaboides* (Fabricius).

Several workers were collected at Abuná, and Madeira-Mamoré Camp 39. It is much less abundant than *D. decollatus*.

155. *Dolichoderus* (*Dolichoderus*) *imitator* Emery.

This is the smallest and most delicate species of the group, and the least common. Five workers were taken at Madeira-Mamoré Camp 39.

The following key serves to separate the Brazilian species of the subgenus Dolichoderus.

Occiput not prolonged into a distinct neck.....1.
Occiput prolonged into a distinct neck.....2.

1. Large, coarse species, epinotal spines long, acuminate; node flattened above, unarmed.....*decollatus* Smith.
   Small, delicate species, finely sculptured, epinotal spines very

short; node in profile triangular, acuminate at apex, which is armed with two small teeth.....*imitator* Emery.

2. Color black, petiolar node in profile flat above, twice as long as thick, epinotal spines rounded, slender.....*rugosus* Smith.
   Color, in part, red. Petiolar node in profile less than twice as long as thick, not flat above; epinotal spines somewhat flattened and slightly rugose toward base.....3.
3. Node from above not twice as long as broad; gaster densely punctured and opaque.....*atellaboides* Fabr.
   Node from above more than twice as long as broad; gaster shining.....4.
4. First antennal joint 4 times as long as thick; length 13 mm. (Ecuador).....*rosenbergi* Forel.
   First antennal joint less than 4 times longer than thick; length 10 mm.....*imbecillus* Mann.

156. *Dolichoderus* (*Monacis*) *bispinosus* (Olivier).

Numerous colonies were found at Pará, Itacoatiara, Porto Velho, and Madeira-Mamoré Camp 39.

This is the commonest, and the most widely distributed species in the genus. It builds carton nests, sometimes of large size, in the branches of trees. The larger of these nests are solidly constructed, similar to certain *termitaria*. I am not certain that some which I examined were not termite nests that had been preëmpted by the ants. When the formicary is disturbed the workers defend it very pugnaciously. They bite hard enough to be disagreeable and the colonies are very populous. I have, on several occasions actually been driven from the near vicinity of a nest by this species.

157. *Dolichoderus* (*Monacis*) *spinicollis* (Latreille).

Workers of this singular species were encountered only once, at Madeira-Mamoré Camp 41. They were found shortly before twilight, moving in a file along a slanting tree-trunk and going up into a tangled mass of vines. Each was carrying in its mandibles a portion of some fluffy, waxy substance. I could not locate the nest, and did not see any more of the ants, though I returned to the same locality several times for further search.

This species is characterized by the very long, acute spines which

project laterally and upward from the sides of the pronotum. The meso- and epinotum each has a stout, triangular spine at the posterior corners, and the node is armed at apex with a slender acuminate spine as long as the node. The whole body is covered with fine yellow pubescence.

158. *Dolichoderus* (*Monacis*) *laminatus* Mayr subsp. *luteiventris* Emery.

A female from Madeira-Mamoré Camp 41 agrees with Emery's description. It measures 5.5 mm. in length. The head, thorax, and petiole are black, and the gaster testaceous, each segment of the latter with a fuscous border. The legs are testaceous.

159. *Dolichoderus* (*Monacis*) *varians*, sp. nov.

Worker. Length 5 mm.

Near *D. lamellosus* Mayr. Head oval, excluding mandibles, a little longer than broad, the sides very convex; occipital angles narrowly rounded, the border narrowly concave. Clypeus flat above, with rounded anterior border. Frontal area very large, triangular. Frontal carinae thin, slightly elevated, extending to opposite posterior third of eye. Eyes small, convex, located in front of sides of head, a little behind the middle. Antennae slender, the scape thickened toward apex, extending a third its length beyond the occipital corners; all the funicular joints longer than broad. Pronotum transverse, broadest in front, the anterior angles drawn out to form acute triangular spines, which are flattened above; anterior border convex at middle, concave at sides; sides sharply but not broadly margined. Mesonotum one and a half times as long as broad, narrowed behind; the surface slightly concave; sides with a narrow elevated margin. Base of epinotum from above triangular, one and a half times as long as broad, sides roundly margined; apical portion transversely depressed and posterior to this elevated into a very thin lamella; declivity a little shorter than the base.

Petiolar node twice as broad as long; in profile twice as high as thick; anterior and posterior surfaces slightly convex, the apex rounded in front, behind elevated into a very thin broad lamella. Gaster short and thick.

Subopaque. Head, thoracic dorsum, and anterior surface of

petiolar node shallowly, densely rugulose. Posterior surface of node and the gaster finely, densely punctate, the latter regularly granulose.

Body thickly covered with short, fine, erect pile. Antennae minutely pubescent.

Color black; antennae and legs ferruginous.

Described from a single worker taken at Porto Velho. In color and general form, as well as in sculpture *D. varians* resembles *D. lamellosus*, from which it differs in the shape of the mesonotum. In the latter species this is transversely oval, while in *D. varians* it is distinctly longer than broad, with a faintly crenulate border. *Dolichoderus varians* is also much more thickly pilose. The other closely related species, *D. laminatus*, has much narrower pronotal spines and finer sculpture throughout.

160. *Dolichoderus* (*Monacis*) *tristis*, sp. nov.

Plate 2, fig. 17.

Worker. Length 4.5 mm.

Head, excluding mandibles, a little longer than broad, narrowed in front, with slightly rounded sides and nearly straight posterior border; occipital corners broadly rounded. Clypeus rounded, the anterior border concave at middle. Frontal carinae nearly straight, subparallel, extending to opposite middle of eyes. Eyes small, feebly convex, located in front of sides of head a little behind the middle. Mandibles short and thick. Antennae short, the scape curved, thickened and flattened toward apex, extending less than one third its length beyond the occipital corners; funicular joints subequal in length, the first constricted at base, joints 3–10 cylindrical, about one and a half times as long as broad; joint 10 as long as broad; apical joint twice the length of penultimate. Pronotum transverse, narrower than head; the short neck transversely depressed; sides convex, acutely margined, the spines short and stout. Mesonotum transverse, sides margined. Epinotum campanulate, unarmed, flat above, the margin projecting laterally and behind; surface of basal portion rounded. Petiole from above transverse; in profile thicker than long, flat above, straight in front, concave behind; the posterior apical border with a short, thick, triangular spine which projects upward and backward; posteroventral surface extended into a triangular process. Gaster short and thick, considerably broader than the thorax.

Subopaque. Head regularly, rugosely punctate, each puncture bearing a short, recumbent glistening white hair. Cheeks and clypeus rugulose. Mandibles shining, coarsely punctured. Antennae densely punctulate. Thoracic dorsum finely punctate; pleurae shining; prothoracic pleurae densely punctate, meso- and epinotal pleurae rugose. Node shining, rugose. First gastric segment densely, irregularly striolate, the striolae longitudinal in front and transverse at the posterior border; remaining segments very densely striolate longitudinally. Legs somewhat shining, punctate.

Thorax and gaster finely pubescent and with scattered erect hairs. Legs sparsely pilose.

Color black; eyes, inner border of mandibles and tarsal joints reddish. Pilosity brownish.

Described from several workers taken at Abuná.

The curious structure of the petiole distinguishes this from the other species of the subgenus.

161. *Dolichoderus* (*Monacis*) *debilis* Emery.

Several workers from Madeira-Mamoré Camp 37 agree closely with cotypes received from Professor Emery.

162. *Dolichoderus* (*Monacis*) *debilis* Emery var. *rufescens* Mann.

The single colony of this very distinct variety was found at Madeira-Mamoré Camp 39, living parabiotically with *Odontomachus affinis* subsp. *mayi*. It differs from *D. debilis* in color, the greater length of the petiolar spines, and the coarse cephalic sculpture.

163. *Dolichoderus* (*Hypoclinea*) *abruptus* (F. Smith).

Many specimens were taken at Porto Velho, Abuná, and Madeira-Mamoré Camp 41. The workers were found most frequently on shrubs, where they attended Membracidae.

164. *Dolichoderus* (*Hypoclinea*) *lugens* Emery.

This species, originally described from Bolivia, swarmed in certain parts of the forest near Porto Velho, and at Abuná, Brazil and Bolivia. It forages on the ground more than do the other species of the genus,

but like the others, nests in trees. The colonies must be very large, judging from the numbers of workers seen together. The workers are able to exude from the anal glands a large drop of a mustard-yellow secretion. This is not, so far as I could ascertain pungent, and it had no effect when applied to my skin.

165. *Dolichoderus* (*Hypoclinea*) *bidens* (Linné).

Taken at Pará, Porto Velho, and Abuná.

166. *Dolichoderus* (*Hypoclinea*) *bidens* (Linné) var. *inferior*, var. nov.

Taken at Itacoatiara and Abuná. This variety is somewhat smaller than typical *D. bidens*, and is light ferruginous in color. The punctation on the vertex is much finer.

167. *Dolichoderus* (*Hypoclinea*) *analis* Emery.

Several workers were taken at Pará and Abuná. It is less common than the preceding species.

168. *Dolichoderus* (*Hypoclinea*) *germaini* Forel var. *garbei* Forel.

Many workers from Ceará and Independencia agree with Forel's description of this variety from Bahia. The head has the sides little convex and much longer than broad; the pronotum is as broad as long. In all of the series the legs are light fuscous and in some of the specimens the thorax is considerably lighter than the rest of the body.

169. *Dolichoderus* (*Hypoclinea*) *ghiliani* Emery.

Plate 3, fig. 19.

Worker. Length 4.5 mm.

Head one and a third times as long as broad, with convex sides, rounded occipital corners and straight border. Clypeus rounded at middle, the anterior border broadly rounded. Mandibles long and thick, the blades finely dentate. Frontal carinae distinct, subparallel, not extending to opposite posterior border of eye. Eyes oval, situated on sides of front, a little anterior to middle of head. Antennae

long and slender, the scape extending one third its length past the occiput, funicular joints 1–7 subequal, cylindrical, nearly three times as long as broad, joints 8–11 a little thicker than the others, apical joint as long as the two succeeding joints together. Pronotum flat, behind, sloping in front, the anterior part considerably narrowed, with margined sides; border between anterior and posterior parts angulate. Mesothorax in front flattened, disc-like; behind sloping into the broad mesoëpinotal impression; the mesothoracic spiracles are large and form distinct tubercles. Base of epinotum longer than the declivity, the surface two and a half times as long as broad, flat and narrowest in front, broadly, shallowly impressed behind, the impressed part acutely margined; posterior border margined, the two margins joining in a prominent, rounded angle; face of declivity rounded. Petiolar node thick, in profile very convex in front, nearly straight behind, the two surfaces separated by a faint margin; the anterior surface rounded, the posterior nearly flat. Gaster elongate and narrower than is usual in the genus. Legs long and slender.

Head, thorax, epinotum, and gaster subshining; seriolately punctulate, devoid of pubescence but bearing sparse, long, erect hairs. Antennae with more abundant and finer, semierect, recumbent pile. Legs finely pilose.

Gaster shining, with sparse, long, erect hairs.

Color light ferruginous, except the gaster, which is piceous.

Described from a single worker taken at Itacoatiara. It is related to *D. lutosus*, but is a more slender species, the epinotal margin is distinctly concave seen from behind, and the head is much longer, with very convex sides, and narrowed behind, and not concave at the border.

170. *Dolichoderus* (*Hypoclinea*) *championi* Forel var. *ornatus*, var. nov.

Worker. Length 6 mm.

Near *germaini*. Head elongate oval, with convex sides and feebly concave occipital border, the angles evenly rounded. Clypeus flattened at middle, anterior border straight. Mandibles as in *D. germaini*. Eyes nearly circular, located at sides of front anterior to middle of head. Antennae slender, the scape bisinuate, extending one third its length past the occipital border; funicular joints all distinctly longer than broad, the first three times, the others about twice. Pronotum flattened, a little longer than broad, the sides rounded in

contour and feebly margined. Mesonotum oval, about one and one half times as long as broad, in profile gently rounded from base to the mesoëpinotal impression, which is broad and deep. Epinotum more than twice as long as broad, with the base a little longer than the declivity; in profile the base is rounded, the declivity slightly convex; the surface of the base is convex, except at the apical end, where there is a narrow shallow transverse impression, posterior to which is a slightly elevated margin; the basal surface is flat. Petiolar node thin, in profile convex in front, concave behind, the apex thinly margined; the margin not extending down the sides.

Head shining, minutely, closely punctate, thinly covered with short, suberect pile; antennae thinly pilose; mandibles punctate and pilose.

Thorax, epinotum, and petiole somewhat shining, punctate, similar to but more coarsely than the head, and more thinly pilose; the posterior surface of the node with fine transverse striolae and glabrous, except for several long hairs at the apex. Thorax shining, minutely punctate, thinly pilose.

Color black, except the legs, petiolar node, base of first gastric segment and interrupted bands at the apices of the first and second segments which are yellow. Apex of femora, tibiæ and tarsi slightly infuscated. Pile gray.

Female. Length 8 mm.

Head elongate oval, distinctly longer than broad, in general similar to that of the worker. Ocelli large and distinct, arranged in a triangle. Mesonotum flat behind, the sides with a low, rounded margin. Scutellum flat. Epinotum similar to that of the worker, but the base is much shorter in proportion to the declivity, slightly longer than broad. Petiole as in worker. Gaster longer and more slender.

Head and pronotum with foveate punctation, the punctures shallow and widely separated.

The color is the same as in the worker, except for the mandibles and a transverse stripe across the clypeus, which are rufous. The tibiae, tarsi, and tips of the femora are darker than in the worker. Wings very slightly infuscated, veins pale brown. Pilosity as in worker.

Described from large series of workers from Pará and Abuná. This is a singularly colored variety, quite different from any of the described forms. In the Pará specimens the surface of the epinotal declivity is yellow, and in those from Abuná it is black. Otherwise the two are identical.

171. *Dolichoderus* (*Hypoclinea*) *lutosus* (F. Smith).

Plate 3, fig. 20.

Several colonies, nesting beneath stones were found at Natal and Baixa Verde. Those from the latter locality are small in size (length 3.5 mm.) and are evidently from an incipient colony. A figure of the worker is given in Plate 3, fig. 20.

Female. Length 6 mm.

Ocelli very small, arranged in an equilateral triangle. Base of epinotum shorter than declivity.

Color similar to that of worker but more pronounced. First three gastric segments with a median longitudinal fuscous line; apex of first segment with a narrow transverse fuscous band; apical two thirds of the second and border of the third segments fuscous. Wings hyaline; veins and stigma brown.

Male. Length 3.75 mm.

Head, excluding the mandibles, as long as broad, convex behind and at sides, with large, moderately convex eyes, which occupy about half the sides. Frontal area distinct, triangular; carinae fine. Clypeus convex at middle, broadly concave at middle of anterior border. Mandibles well developed, stout, as long as the distance from their base to the eye, blade with several fine teeth anteriorly. Vertex elevated into a broad tubercle on which the large ocelli are located; in front of this, beneath the median ocellus the front has a deep, triangular impression. Antennae short, extending to base of gaster; first funicular joint a third the length of the second. Thorax robust, mesonotum evenly rounded above, with feeble Mayrian furrows. Epinotum short, base rounded, declivity flat, the two surfaces separated by an obtuse angle. Petiole twice as high as thick, anterior surface rounded, posteriorly nearly flat, the apex narrowly, thickly margined. Gaster similar to that of worker, but flattened above. Genitalia small. Hypopygium small, broadly triangular. Cerci very small. Legs slender. Wings long and narrow.

Body shining, very minutely punctate. Mandibles punctate, with several long hairs. Body without long hairs. Thorax and abdomen with sparse, regular, very minute scale-like white hairs. Funiculus densely pubescent.

Color dark fuscous, gastric segments at base lighter.

172. *Azteca schumanni* Emery subsp. *dubia*, subsp. nov.

Plate **2**, fig. 15.

Worker major. (Plate **2**, fig. 15). Length 2 mm.

Head subquadrate, one and a third times longer than broad, slightly narrowed in front, with feebly convex sides, broadly rounded occipital corners and narrowly excavated border. Clypeus convex, the anterior border broadly bisinuate. Antennal scapes extending about two thirds the distance to occipital corners; strongly arcuate and thickened toward apex; funicular joints 5–10 as broad as long. Eyes at sides of head, well in front of the middle. Pro- and mesothorax as in *A. schumanni*. Epinotum in profile rounded; the posterior portion of base flattened. Node in profile twice as high as thick, evenly rounded above. Antennal scapes and tibiae without erect pile.

Head, thorax, and abdomen with fine, long, appressed pubescence and sparse, short, erect hairs.

Color fuscous, thorax lighter, gaster darker.

Worker minor. Length 2 mm.

Head longer than broad, the width at occiput equal to that at clypeus; sides slightly convex, posterior border very feebly concave. Clypeus convex, the anterior border truncate at middle, slightly produced and rounded at corners. Eyes small, located in front of sides anterior to middle of head. Antennal scapes extending about two thirds the distance to occipital corners, funicular joints 6–10 as broad as long. Thorax and epinotum similar to that of the worker major, but the latter is somewhat flatter. Node and gaster as in the worker major.

Subshining, finely punctate. Body above with sparse, short pile and pubescence. Antennae and legs pubescent, without erect pile.

Color fuscous.

Male. Length 3.5 mm.

Head about as long as broad; sides and posterior border convex. Mandibles slender, acuminate. Anterior border of clypeus rounded. Eyes rather large and convex. Ocelli prominent, the lateral ones situated at opposite ends of a transverse elevated tubercle, which is rounded in front and behind. Antennae short and stout; first and second joints subglobose, transverse, the second the longest; third joint one and a half times longer than broad, very much thickened; joints 4–6 distinctly longer than broad, joints 7–12 proportionately shorter; apical joint one and a half times as long as penultimate.

Thorax robust, the anterior surface of the pronotum declivous in profile. Petiole and gaster similar to those of the worker minor.

Body and legs without erect pile, sparsely pubescent. Antennae, excepting the first two joints, very densely covered with rather long, erect pubescence.

Color black, legs and antennae dark fuscous. Wings hyaline. Veins and stigma fuscous.

Described from four major workers, three minors, and a male from Itacoatiara. This form differs from the typical *A. schumanni* in not having erect hairs on the antennal scape, the head is less narrowed in front, and the clypeus is not depressed at the middle. *Azteca schumanni* var. *taediosa* Forel is more robust and has the head less excavated behind and the antennal scapes longer.

173. *Azteca mülleri* Emery subsp. *terminalis*, subsp. nov.

Plate 2, fig. 16.

Worker major. Length 4 mm.

Head, excluding mandibles, as broad as long, narrowed in front, with strongly convex sides, especially opposite the eyes, narrowly rounded occipital corners and deeply excavated border. Clypeus convex, the anterior border straight, except at corners, where it is slightly produced and rounded. Mandibles thick, with six strong teeth. Antennal scapes barely extending to occipital corners. Mesonotum in profile evenly rounded. Epinotum with subequal base and declivity, the former broadly flattened. Node rather low, rounded above. First segment of gaster depressed in middle at base.

Shining, densely punctate throughout. Pubescence abundant, long and recumbent. Pile of the scapes sparse and short, that of the body longer.

Color very dark fuscous; terminal half of antennae yellow, the color becoming more intense at apex.

Described from a series taken at Madeira-Mamoré R. R. Camp 39. The broadly flattened epinotum and the peculiar coloration of the antennae distinguish this subspecies. It is evidently close to var. *A. nigella* Emery from southern Brazil, but is larger and differently colored.

174. *Azteca aurita* Emery subsp. *silvae* Forel.

A single colony of this distinct subspecies was found at Pará, the type locality.

175. *Azteca velox* Forel var.

Colonies were found at Manaos, Abuná, Porto Velho, and Madeira-Mamoré R. R. Camps 39 and 41. There is considerable variation in the amount of infuscation on the vertex.

176. *Azteca angusticeps* Emery.

A single deälated female from Itacoatiara agrees closely with Emery's figure and description of this species.

177. *Azteca alfaroi* Emery var.

Several workers of a variety of this species were taken at Abuná. These are very close to var. *A. aequilata* Forel, but the sides of the head are more convex.

178. *Azteca trigona* Emery.

Numerous workers were taken at Manaos and on the Rio Madeira at Camps 35, 39, 41, 43, Porto Velho, and Abuná.

179. *Azteca trigona* Emery subsp. *mathildae* Forel.

This was the most abundant Azteca on the Rio Madeira. Specimens were taken at Abuná, Porto Velho, and Madeira-Mamoré R. R. Camp 43. At Itacoatiara many colonies were nesting in high, buttressed trees near the river bank.

180. *Azteca trigona* Emery subsp. *mathildae* Forel var. *spuria* Forel.

A number of colonies, in small carton nests, six or eight inches in length, were found at Ceará-Mirim. Other colonies of a variety identical with this were found at Abuná on the Rio Madeira. The latter attend Coccidae of several species, over which they build sheds. The coccids which I observed were on small bushes near the trees on which the formicaries were built. The ants energetically defended the sheds and the Coccidae.

181. *Azteca barbifex* Forel.

Very abundant at Abuná and Madeira-Mamoré Camps 28, 39 and 41. The type specimens are from the Rio Purus and the species is probably widely distributed throughout the upper Amazonian region.

182. *Azteca chartifex* Forel var.

Several workers of a variety of this species were taken at Abuná.

183. *Azteca fasciata* Emery var. *similis*, var. nov.

Minor and major workers from colonies found at Madeira-Mamoré Camps 39 and 41 differ from Emery's description and figure of *A. fasciata* from Santarem in color and in having the antennal scape noticeably longer. In the smaller worker of *A. fasciata* it extends barely past the occipital corners while in *A. similis* it exceeds these corners by a full third of its length. In *A. similis* the larger workers have the head, pronotum, anterior femora, and antennal scapes red, and the rest of the body dark fuscous. The smaller workers have the vertex, and part of the pronotum infuscated. In other characters it agrees closely with typical *A. fasciata*.

184. *Azteca lanuginosa* Emery subsp. *pruinosa*, subsp. nov.

Worker. Length 3.5 mm.

Head, excluding mandibles, as broad as long, appreciably narrowed in front, with strongly convex sides, narrowly rounded occipital corners and shallowly excavated border. Clypeus convex, the anterior border bisinuate, projecting and rounded at middle. Mandibles with a thick, blunt subapical tooth and five small teeth on the blade. Antennal scapes in the largest workers barely attaining the occipital corners, in the smaller ones slightly surpassing them. Mesonotum very convex and elevated. Mesoëpinotal suture strongly impressed. Node in profile deeper than thick, evenly rounded above.

Mandibles subopaque, densely striolate longitudinally. Head, thorax, and abdomen subopaque, finely, densely punctate.

Head and body evenly covered with fine pruinose pubescence. No erect hairs present, except a very few on the gaster.

Color dark fuscous; clypeus, antennal scapes and legs lighter.

Described from a number of workers taken at Abuná. This form is less shining than *A. lanuginosa*, the pubescence is more abundant and is closely appressed and not lanuginose in character. Otherwise the variety agrees with the typical form.

185. *Dorymyrmex pyramicus* (Roger).

Many workers were found at Natal, and Itacoatiara. In the yard of our house at Natal this and the succeeding variety were very abundant, in small crater nests.

186. *Dorymyrmex pyramicus* (Roger) subsp. *flavus* McCook.

Very common at Natal. This and the preceding have a wide distribution, ranging from Illinois in the United States to Argentina. Strangely, in spite of the adaptive nature of this ant, it has not spread out of the Americas.

187. *Tapinoma melanocephalum* (Fabricius).

Many specimens of this common tropicopolitan species were found at Pará and Porto Velho.

CAMPONOTINAE.

188. *Brachymyrmex coactus* Mayr.

One colony was found at Independencia, nesting in a twig.

189. *Brachymyrmex admotus* Mayr.

One colony was taken at Ceará-Mirim.

190. *Brachymyrmex pictus* Mayr.

Taken at Pará and Manaos.

191. *Myrmelachista* (*Decamera*) *bambusarum* Forel.

Workers taken at Itacoatiara agree with Forel's description of this species from Sao Paulo. The type specimens were nesting in bamboo.

192. *Gigantiops destructor* (Fabricius).

Found commonly at Pará, Abuná, Porto Velho, and Madeira-Mamoré Camps 39 and 41. In life this was one of the most

attractive ants encountered. It lives always in the forest, where it forages either among the branches of trees or on the ground. The movements of the foraging worker are rapid, comparable to those of some of our species of Cicindela, and the bicolored antennae are kept constantly in motion.

The female is very similar to and scarcely larger than the biggest worker and the eyes and ocelli are equally well developed in both.

193. *Prenolepis* (*Nylanderia*) *longicornis* (Latreille).

Santarem, Natal, and Maranhao.

194. *Prenolepis* (*Nylanderia*) *vividula* (Nylander).

Several colonies were found at Pará.

195. *Prenolepis* (*Nylanderia*) *fulva* Mayr.

Itacoatiara.

196. *Prenolepis* (*Nylanderia*) *steinheili* Forel.

Independencia.

197. *Camponotus* (*Myrmoturba*) *maculatus* (Fabricius) subsp. *fusco-cinctus* Emery.

Several workers and females were found beneath bark at Natal.

198. *Camponotus* (*Myrmoturba*) *maculatus* subsp. *fryi*, subsp. nov.

Plate 6, fig. 52.

Worker major. Length 10 mm.

Close to subsp. *C. spengleri* Forel. Head a little longer than broad, truncate behind, with broadly rounded posterior corners and slightly convex sides. Clypeus strongly carinate; the anterior border notched at middle. Cheeks in front broadly rounded. Thorax and petiolar node in profile thicker than in the other forms of *C. maculatus*, the anterior face of the latter very convex. The front and vertex are

sparsely punctate, the punctures comparatively coarse. Pubescence is lacking and pile sparse.

Color brown, the head darker; the basal parts of gastric segments are transversely banded with light ferruginous.

Described from a single specimen taken at Madeira-Mamoré Camp 39. This subspecies is distinguished from the others by the thicker thorax and petiolar node and the very sparse pile.

199. *Camponotus* (*Myrmoturba*) *maculatus* subsp. *abunanus*, subsp. nov.

Plate 6, fig. 44.

Worker major. Length 7 mm.

Head, excluding mandibles, longer than broad, narrowed in front, with convex sides; posterior border excised, straight at middle, the angles prominent, and clypeus longer than broad, very broadly carinate at middle, the anterior border bilobed. Mandibles stout, with five rounded teeth. Antennae slender, the scapes barely reaching to occipital corners of the head. Thorax slender; pronotum distinctly longer than broad. Epinotum from above four times as long as broad; in profile slightly rounding from base to declivity, the two surfaces joining in a broadly rounded angle. Petiolar node wedge-shaped in profile, the anterior surface rounded, the posterior nearly flat; seen from behind its margin is evenly rounded. Legs short; the tibiae not compressed.

Subshining; very finely shagreened, the head and pronotum less so than the rest. Mandibles sublucid, with fine punctures and few short hairs. Front with a few coarse superficial punctures. Pubescence of the head very minute, sparse, and scale-like; a few short erect hairs on the front and occiput. Thorax and abdomen with silky pubescence, which is most abundant on the gaster. Pile long and sparse on the thorax, shorter and abundant on the gaster.

Color testaceous; mandibles, antennal scapes (except tip), tarsi, and a narrow transverse band at the apex of each gastric segment dark fuscous. Pile and pubescence yellow.

Described from two major workers from Porto Velho. Possibly this should be considered a distinct species. The occipital angles of the head are unusually narrow, the clypeus more deeply notched and the antennal scapes are shorter than in the other forms of *C.* (*M.*) *maculatus*.

200. *Camponotus* (*Myrmoturba*) *melanoticus* Emery var. *substitutus* Emery.

Numerous workers were found at Natal, Independencia, and in the Maranguapé Mountains. The species nests beneath stones.

201. *Camponotus* (*Myrmothrix*) *rufipes* (Fabricius).

The typical form of this species was common, nesting in logs and beneath bark, at Ceará-Mirim, Pará, and Porto Velho.

202. *Camponotus* (*Myrmothrix*) *abdominalis* (Fabricius).

Very common at Natal, Ceará-Mirim, Baixa Verde, Pará, and Madeira-Mamoré Camps 39 and 46.

203. *Camponotus* (*Myrmothrix*) *abdominalis* var. *atriceps* F. Smith.

A single colony was taken at Abuná, Bolivia.

204. *Camponotus* (*Myrmothrix*) *rapax* (Fabricius).

Plate 5, fig. 38.

Worker major. (Plate 5, fig. 38). Length 12 mm.

Head one and a third times longer than broad, narrowed in front, posterior angles narrowly rounded, occipital border narrowly and rather deeply concave; the sides straight and subparallel until a little in front of middle, then convergent. Mandibles large, elongate, with six teeth on the blade. Clypeus a little broader than long, attaining side margin of head, strongly carinate, the anterior border of middle convex. Frontal area distinct, quadrangular. Frontal carinae evenly curved from base to end, which is opposite the middle of eye. Eyes small, rather flat. Antennae slender, the scapes bent at middle, extending three eighths their length beyond the occipital corners; funicular joints long and cylindrical, gradually decreasing in length apically. Pronotum broader than long, rounded at sides and above, in front finely margined. Mesonotum slightly longer than broad, narrowed behind, the base slightly less than twice the breadth of posterior portion. Epinotum at base divided by a distinct transverse suture; evenly rounded in profile; narrow above, three times as long as broad.

Petiolar node from above transverse, rounded at sides and in front; in profile narrow, two and one half times higher than thick, rounded at apex, the posterior surface nearly straight, the anterior slightly more convex. Gaster elongate egg-shaped. Legs long and slender.

Subopaque, the whole body finely shagreened, somewhat more coarsely on the head and more finely on the petiolar node. Mandibles coarsely punctate and sparsely setose. Antennal funiculus coarsely punctate.

Body with long, recumbent, silky, glistening hairs and very long erect pile. The appressed pubescence is most abundant on the gaster, thoracic pleurae, and head and absent from the petiolar node. Legs with short semidepressed hairs, femora sparsely beset with long stiff hairs. Antennal funiculus pubescent; scape with short semidepressed and sparse, longer, erect, stiff hairs.

Color black except a transverse reddish brown patch on the occiput and the dorsum of the gaster, which is light ferruginous. Pubescence yellow, pile brown.

Worker minor. Length 10 mm.

Head twice as long as broad, as broad in front as behind, with slightly convex sides and narrowly rounded occipital border. Antennal scapes extending nearly two thirds their length past the occipital borders. Thorax shaped much as in worker major. Posterior surface of petiolar node shallowly impressed at middle.

Sculpture, pilosity, and color much as in worker, but the head is entirely black.

Described from one worker major and a series of minor workers from Porto Velho and Madeira-Mamoré Camps 39 and 41. This distinct species is generally distributed throughout the Amazon region and the northern parts of South America, but it is not common locally.

205. *Camponotus* (*Myrmothrix*) *leydigi* Forel.

Workers were found on tree trunks at Independencia and Manaos.

206. *Camponotus* (*Myrmothrix*) *wheeleri*, sp. nov.

Plate 6, fig. 49–51.

Worker major. (Plate 6, fig. 50). Length 12 mm.

Head very large, nearly as broad as long, narrowed in front, with slightly convex sides, elongate, narrowly rounded occipital corners

and sharply truncate posterior border. Eyes small, slightly convex. Mandibles small, short, with four coarse teeth. Clypeus about as broad as long, carinate, the anterior border broadly concave. Frontal area distinct. Frontal carinae more approximate in front than behind. Antennae short and slender, the scapes curved, extending one eighth their length past the occipital corners; funicular joints 1–3 subequal, more than three times as long as broad, joints 4–6 subequal, slightly shorter than the first three, the rest of the joints still shorter and subequal in length. Pronotum one half as broad as the head, the anterior border and the front of sides with a rounded carina. Meso- and epinotum in profile evenly arched above; from above, rounded at sides. Petiolar node in profile about as thick as long, moderately convex in front, nearly straight behind; from above as broad as long, evenly rounded in front and behind. Legs very long, the tibiae and metatarsi broad and very much depressed.

Sublucid throughout, the whole body finely shagreened, more coarsely on the head; with a covering of silky, recumbent pubescence, which is less abundant on the head, pro- and mesonotum, and the petiolar node; with long, stiff, erect hairs on the head, thorax, gaster, and legs; the head in addition bears shorter, suberect hairs.

Body and legs black, the gaster on account of the dense, silky pubescence has a yellow sheen; head reddish brown, the antennal scapes black. Pubescence and short fine pile yellow; coarse hairs black.

Worker minor (Plate 6, fig. 49, 51). Length 9 mm.

Head a little longer than broad, narrowed in front, the sides nearly straight; occipital corners broadly rounded; posterior border straight. Clypeus with straight, projecting anterior border. Antennae long, the scapes extending three fourths their length past the occipital corners of the head. Thorax and petiole similar to that of worker major. Legs as in worker major.

Sculpture, color, pile, and pubescence as in worker major, but the pubescence of the gaster is somewhat finer.

Described from a small series which was collected at Madeira-Mamoré Camp 41. The ants were nesting in a hollow palm tree and it was necessary to smoke them out. Their movements in life were very active.

The peculiar shape of the thorax, the strongly flattened long legs and the color are very distinctive.

207. *Camponotus* (*Myrmamblys*) *burtoni*, sp. nov.

Plate 6, fig. 45, 46.

Worker maior. Length 6 mm.

Head, excluding mandibles, longer than broad, broadest at occiput; posterior corners narrowly rounded, the border slightly convex; sides in front of eyes straight. Head in profile two thirds as thick as long. Clypeus a little broader than long; anterior border narrowly rounded at middle; surface very convex, with a strong carina at middle. Frontal carinae weak, extending to opposite the anterior border of eyes. Eyes small, convex, situated on sides back of posterior third of head. Antennae long and slender, scape extending half its length past the occipital corners, funicular joints long, cylindrical. Mandibles short and thick, the blade with four teeth. Pronotum twice as broad as long, the surface rather flat, sides nearly straight; anterior angles evenly rounded; sides and anterior border with a rounded margin. No mesoëpinotal suture; the mesoëpinotum rounded above, then declivous to base, in profile twice as high as thick. Node wedge-shaped, twice as deep as thick, the anterior and posterior surfaces feebly convex; narrowly rounded above.

Sublucid, head, thorax, and abdomen very densely, transversely, striolately punctate, with long silky pubescence, which is rather sparse except on the front of head and the pronotum, and abundant, stiff, erect pile, which is very long. Node without pubescence but bearing several long hairs at the apex. Antennae pubescent, devoid of pile. Femora and tibiae sparsely pilose.

Color black; mandibles and scape rufous. Pile and pubescence white.

Described from three workers taken at Madeira-Mamoré Camps 39 and 41.

208. *Camponotus* (*Myrmamblys*) *novagrenadensis* Mayr.

Two major workers were taken at Abuná.

209. *Camponotus* (*Myrmamblys*) *claviscapus* Forel.

Many major and minor workers of this species, from Natal and Ceará-Mirim, agree closely with Forel's description of the types, which were from Trinidad.

210. *Camponotus* (*Myrmobrachys*) *adpressisetosus* Forel.

Plate 6, fig. 48.

Worker major. (Plate 6, fig. 48). Length 9 mm.

Head, excluding mandibles, longer than broad, with narrowly rounded occipital corners and concave border; sides nearly straight and subparallel for half their distance from occiput to anterior border, then convex and convergent. Clypeus longer than broad, strongly keeled at middle, the sides straight and parallel; anterior border broadly concave at middle. Frontal area distinct, elongate, triangular. Frontal carinae extending to nearly opposite the posterior borders of eyes. Eyes small, very flat, located in front of sides behind the middle. Mandibles 4-dentate. Antennae short, slender, the scapes curved, extending three fourths the distance to occipital angles, funicular joints cylindrical, joints 2–10 subequal. Pronotum transverse, sides evenly rounded, surface slightly convex. Mesonotum flat above, a little broader than long, evenly rounded at sides. Mesoëpinotal suture faintly impressed. Epinotum from above three times as long as broad; evenly rounded above and at sides, without distinct base and declivity. Petiolar node twice as high as thick, rounded in front, nearly straight behind, above narrowly rounded. Gaster short and stout, oval. Legs long, tibiae moderately depressed.

Subopaque, very finely shagreened throughout, with a covering of fine silky pubescence, which is a little more abundant on the gaster and thorax than on the head. The head bears short, stiff suberect hairs, in addition to much longer erect hairs. The latter are present also on the thorax and gaster, where they form a long brush on the epinotum and the apex of node. Antennae without pubescence or pile. Mandibles subshining, finely punctate, with sparse, short hairs. Legs with sparse, fine recumbent hairs; without erect hairs.

Color black; antennae and mandibles brown, recumbent pile and pubescence golden.

Worker minor. Length 7 mm.

Head, excluding mandibles, longer than broad, narrowed in front, with slightly convex sides, broadly rounded posterior corners and straight occipital border. Clypeus as broad as long, strongly keeled at middle. Mandibles 7-dentate. Antennal scapes extending half their length past the occipital corners. Eyes large, moderately convex, located at posterior third of head. Thorax much as in major worker, but the mesoëpinotal suture less impressed. Rest as in worker major.

Many workers were taken at Ceará-Mirim, Natal, and Maranhao, from nests beneath stones.

211. *Camponotus* (*Myrmobrachys*) *crassus* Mayr.

This was the commonest of the genus on the east coast, where many workers, females, and males were taken at Natal, Ceará-Mirim, Baturité Mountains, and Maranhao.

212. *Camponotus* (*Myrmomalis*) *depressus* (Fabricius).

Plate 5, fig. 42.

Taken at Abuná, Bolivia and Madeira-Mamoré Camp 39. This is one of the most singular ants, on account of its very elongate, flat body and the extremely long legs. The few workers which I observed were running about on leaves.

213. *Camponotus* (*Myrmepomis*) *sericeiventris* (Guérin).

Abundant on the Rio Madeira at Abuná and Camps 39 and 41.

Some years ago Mr. E. J. Newcomer gave me a live worker major of this species which was found in a restaurant at Palo Alto, California, having no doubt been imported with bananas from Central America.

214. *Camponotus* (*Myrmorhachis*) *latangulus* Emery.

Workers from Pará, Manaos, and Madeira-Mamoré Camp 39 are a trifle lighter in color than a series from Peru, but are otherwise identical.

215. *Camponotus* (*Myrmeurynota*) *heathi*, sp. nov.

Plate 5, fig. 40, 41.

Worker major. (Plate 5, fig. 41). Length 5.5 mm.

Head nearly as broad as long; sides straight from occipital corners to three fourths the distance to anterior border, then concave; rounded anteriorly. Occipital corners broadly rounded, the margin nearly straight. Frontal carinae narrow, not much elevated. Frontal area broad, slightly convex, anteriorly as broad as the base of clypeus,

with faint longitudinal impression. Clypeus small, longer than broad, anterior border truncate, strongly carinate at middle and depressed on either side. Mandibles short and thick; bluntly dentate. Eyes small, oval, rather flat, situated much posterior to middle of sides of head. Antennae short, stout, the scape strongly inflexed, thickened at apex, barely extending to occipital corners; funicular joints thick, subequal. Pronotum as broad as long, constricted in front, the sides margined, anterior border strongly margined. Sides at middle straight, in front concave to apex, with an angle between; narrowed and rounded at base. Promesonotal impression distinct. Mesonotum triangular, rounded at sides, and slightly rounded above. Epinotum rounded at sides; at base with a large projection, which, seen from the front, has straight sides and truncate apex; from the sides this is seen to be composed of two tubercles, the one in front about half as large as the other. From the apex of this spine the epinotum in profile is concave to a point a little less than half the distance to base, where it is armed with another projection. In profile the anterior surface of this is convex, the posterior concave. This projection is twice as high as the one anteriorly and at the apical end bifurcate into two conical spines. From this to the marginate base the epinotum is concave. Petiolar node in profile thick at base and at about one third the distance from base to apex strongly constricted; apex and sides thinly marginate, the middle and the apex of sides with conical projections; anterior surface rounded, posterior deeply concave. Gaster elongate, sides slightly convex, the width of the first three segments subequal. Legs long, rather stout.

Head and thorax subopaque, minutely and densely punctate, the punctures on mesonotum and epinotum coarser. Head and pronotum with very sparse pubescence and very sparse, scattered semierect pile. Mandibles shining, with coarse punctures. Antennae finely pubescent, the apex of scape with a few erect hairs. Posterior surface of node coarsely striolately punctate, surface granular in appearance. Gaster subopaque, densely punctate, with scattered pubescence and a few erect hairs. Tibiae with sparse recumbent pubescence, but legs otherwise without hairs.

Gaster above dark brown to black, each segment with a narrow apical border of yellow; rest of body and legs ferruginous, tibiae, tarsi, and antennae somewhat darker. Pile and pubescence gray.

Worker minor. (Plate 5, fig. 40). Length 4.5 mm.

Head narrowed anteriorly; sides in front of eyes slightly convex to the anterior border, which is rounded; occipital corners very

broadly rounded; occipital margin straight. Frontal carinae well elevated in front; frontal area convex. Clypeus rounded in front, longitudinally carinate at middle. Mandibles thick, the blade with five teeth. Eyes oval, convex, located at middle of sides of head. Scape of antennae extending nearly half its length beyond occipital corners, slightly bent, and thickened at apex; joints of funiculus subequal in length, each about twice as long as broad. Pronotum convex, one and one half times as broad as long, broadest in front; anterior border convex, posterior concave; sides in front broadly margined, the anterior corners laminate. Mesonotum obliquely flattened at sides, carinate at middle; the carinae, at junction of meso- and epinotum extended into a long projection which is bent backward and flattened at apex. At the base of the pronotum, on the sides is a small, but distinct tubercle. Epinotum carinate at middle; the sides very oblique. Slightly posterior to middle of epinotum is a second projection, longer than the first, and thicker at base; seen in profile this is bent backward; it is tuberculate on the front surface at a little less than half the distance to apex. The apex is deeply bifurcate for nearly one half the length of spine. From the base of this projection the epinotum is concave to base. Node of petiole, seen in profile, longer than high; seen from behind about as thick as high. The apex slightly margined, with three long, acuminate spines, one at apex, and others at middle of sides. Posterior surface of node flattened. Gaster elongate, sides slightly convex. Legs long, rather stout.

Head, thorax, and epinotum subopaque, finely punctate. The punctures are very dense on the head and pronotum, giving these portions a velvety appearance. Head and pronotum with regular, recumbent pubescence, the head with a very few short, erect hairs. Antennae sparsely pubescent. Surface of posterior declivity of petiolar node granular. Gaster densely, minutely punctate, with thin pubescence and sparse, short erect pile. Legs sparsely hairy.

Head above fuscous; each occipital corner with a ferruginous blotch that extends in front of and beneath eye. Front of head, from a short distance beneath insertion of antennae yellow. Mandibles light ferruginous. Antennae fuscous, the scape at basal half ferruginous. The apical border of first gastric segment, the remaining segments of gaster and the apices of tibiae fuscous, rest of body and legs ferruginous. Pile and pubescence white.

Porto Velho, Abuná, and Camp 39 on the Madeira-Mamoré R. R. The specimens were found running about on leaves.

The subgenus Myrmeuryota includes the species which have the meso- and epinotum armed with spines. Of the nine known species, all excepting *C.* (*M.*) *heathi* and *C.* (*M.*) *eurynotus* Forel are West Indian. The latter species, described from a worker minor from Tonantins in Brazil has the pronotum much broader than in *C.* (*M.*) *heathi*, the epinotum is different and the petiolar node is not spinose. Like *C.* (*M.*) *cristophei* and *C.* (*M.*) *toussainti*, which I found on leaves and tree trunks in Hayti, *C.* (*M.*) *heathi* is probably an arboreal species.

I have much pleasure in dedicating this extraordinary species to my former professor, Dr. Harold Heath, a member of the Stanford Expedition and my companion on many collecting trips.

216. *Dendromyrmex traili* May. *rufogaster*, var. nov.

Several specimens in the Wheeler collection from Bolivia (Staudinger) differ from Mayr's description in having the gaster chestnut red, instead of black. In other characters these agree well with the description, and should, I think be considered a distinct variety of *D. traili*.

217. *Dendromyrmex nidulans* Smith.

One specimen, referable to this species, taken at Camp 39, Madeira-Mamoré R. R. *Dendromyrmex nidulans* most closely approaches *D. fabricii* Roger but has not a dense mat of pubescence on the gaster.

218. *Dendromyrmex fabricii* Roger.

One worker from Pará.

219. *Dendromyrmex chartifex* Smith var. *felis*, var. nov.

The worker of this variety differs from the typical form in being subopaque instead of shining. The whole body is more hairy. The dense pubescence on the gaster gives it a velvety appearance. The color is yellowish brown.

Female (deälated). Length 10.5 mm.

Head small, sides in front of eyes almost straight, curving slightly towards base of clypeus; sides behind eyes convex to posterior margin, which is slightly concave. Clypeus broad, carinate, the anterior

border truncate. Mandibles with six teeth. Eyes small, situated posterior to middle of sides of head. Ocelli small. Frontal lamellae elevated; enclosed area very slightly impressed at middle. Antennae about two thirds as long as body. Pronotum narrow, anterior border with raised margin which extends part way along the sides. Mesonotum much elevated, declivous in front, flattened above, with faint indications of margin at sides. Epinotum rounded above and at sides, margined at base. Node as in worker. Gaster ovate. Legs long and slender.

Head, thorax, epinotum, and node subopaque, densely, finely punctate, minutely striolate transversely, with very sparse pubescence, but with abundant, semierect pile.

Gaster subopaque, densely punctate and striolate, both punctures and striae being extremely minute. The pubescence is very sparse and fine; the pile erect, not abundant.

Scape of antennae and legs with many erect hairs; funiculi pubescent.

Color as in worker.

Described from several workers and a female taken at Tumatumari, British Guiana (Amer. Mus. Nat. Hist. collection).

220. *Dendromyrmex chartifex* subsp. *mamoreënsis*, subsp. nov.

Worker. Body much more robust than in the typical form of the species. Head constricted behind the eyes, sides convex, occipital border with edge rounded, without trace of margination. Sides of head in front of eyes evenly convex, narrowed toward base of clypeus. Clypeus strongly carinate. Mandibles with six teeth on the blade. Surface of frontal area convex, longitudinally carinate at middle. Antennae nearly as long as body, rather thick. Pronotum nearly as broad as long, depressed, and broadly margined anteriorly; seen in profile, the surface is convex; sides distinctly margined for three fourths the distance to promesonotal suture. Mesonotum slightly convex above, rounded at sides. Epinotum flattened, sides marginate. Petiolar node, seen in profile on anterior side straight and perpendicular at base, then sloping to apex, with an acute angle between the two surfaces; posterior surface convex; from behind, evenly rounded above. Gaster ovate, short and thick. Legs long and slender.

Body nearly opaque, gaster subshining; antennae and legs sublucid.

Head, thorax, and abdomen finely, densely punctate and striolate, with abundant closely appressed pubescence, which gives the insect a velvety appearance. Body everywhere, except on funiculus, with numerous erect or suberect hairs.

Color dark ferruginous, legs lighter. Pile and pubescence gray. Camp 39 Madeira-Mamoré R. R.

This subspecies differs from typical *D. chartifex* in its more robust form, proportionately larger head and the opaque or semiopaque structure of the integument. In a series of *D. chartifex* from Bon Lugar on the Rio Purus (Coll. Goeldi, det. Forel) before me, the whole body is much more shining than in *D. mamoreënsis*, and the pubescence much more sparse. The head is proportionally smaller, and the occipital margin is distinctly, though narrowly, margined.

221. *Dendromyrmex madeirensis*, sp. nov.

Worker. Close to *D. apicalis.*

Head with sides in front of eyes evenly convex, considerably narrower at base of clypeus than in front of eyes; sides of occiput convex; occipital border narrowly, but distinctly margined; the sides, seen from above, angulate. Eye situated distinctly behind middle of head. Frontal area broad, convex, faintly longitudinally impressed at middle. Clypeus strongly carinate; the anterior border slightly concave; mandibles with six teeth. Antennae long and slender. Pronotum longer than broad, sides submarginate; strongly impressed and margined at anterior border. Surface, except for anterior depression, slightly convex. Mesonotum rounded above and at sides. Epinotum seen in profile, convex from apex to base; sides weakly margined, surface flat. Apex of node, seen in profile acutely angulate, from behind truncate, the sides near apical margin nearly straight, forming an angle with the apical margin. Gaster ovate. Legs long and slender.

Head shining, finely striolate and punctate, with rather sparse pubescence and abundant semierect pile. Scape of antennae shining, coarsely punctate, without pubescence, but with much long erect pile; funiculus thickly pubescent, with short pile. Pronotum shining, sparsely punctate, with sparse, long, recumbent and a few erect hairs. Mesonotum more densely punctate and more thickly pubescent than the pronotum. Epinotum and petiole semilucid, finely striate transversely, the former with very sparse pubescence and a few long, erect

hairs, the latter without pubescence, but with a few erect hairs. The first segment of gaster shining, minutely striolate, with very sparse appressed hairs and a few long ones. Rest of gaster more pubescent, and pilose, striolate, semishining. Legs shining, femora and tibiae pilose, tarsi with semiappressed pubescence.

Color black, except legs, which are dark reddish brown. Pile and pubescence gray.

Described from one worker taken at Abuná, Rio Madeira.

222. *Dendromyrmex apicalis*, sp. nov.

Plate 6, fig. 43.

Worker. Length 8.5 mm.

Head one and one fourth times as broad as thorax, with sides in front of eyes very slightly convex; behind eyes narrowed to near the base, then reflexed outward, forming a short, but distinct neck. Frontal laminae short and protruding. Clypeus longitudinally carinate. Mandibles thick, the blades with six acute teeth. Antennae long and slender, the scape extending a little past the promesothoracic suture. Eyes hemispherical. Frontal area but little longer than broad; with a strong longitudinal impression. Eyes small, hemispherical, located only slightly behind and beneath middle of sides of head. Pronotum noticeably longer than broad; sides round, in front semimarginate; surface slightly convex posteriorly, flattened anteriorly, but not disciform. Mesothorax as broad as long; sides evenly rounded, seen in profile slightly convex, with faint depression at middle. Epinotum a little over three times as long as broad, sides slightly convex, evenly margined; in profile evenly convex from apex to base, surface flattened. The perpendicular anterior surface, and the slanting anterior surface of the petiolar node form an acute angle at the apex. Postpetiole with slight depression at middle; apex, seen from behind rounded. Gaster suboval. Legs long and slender.

Body, except gaster and legs, sublucid throughout, gaster shining. Head and thorax finely, transversely striolate, the striae more coarse on the epinotum and petiolar node, but extremely delicate on the gaster. Body finely punctate, each puncture with a short, recumbent hair.

Scape of antennae with a thin pubescence; funiculus with thicker

pubescence. The head, coxae, and gaster with a few long hairs, other parts of body without them.

Color black, apical four joints of antennae brown, tarsi brown.

Described from one worker taken at Madeira-Mamoré R. R. Camp 39.

The elongate pronotum which is only faintly depressed anteriorly, the shining black color throughout, the brown tarsi and tips of the antennae and the nearly entire absence of pilosity, distinguish *D. apicalis* from the other species of the genus. It approaches most closely *D. madeirensis* from the same region, but differs from this in the shape of the head, the rounded sides of pronotum, the structure of the petiolar node, and in the extremely sparse pubescence and pilosity.

223. *Dendromyrmex branneri*, sp. nov.

Plate **6**, fig. 47.

Worker. Length 8 mm.

Head about one and one half times as long as broad, sides in front of eyes slightly convex, slightly broader at base of clypeus than in front of eyes, anterior corners angulate; occiput strongly contracted, seen from above with almost straight margin to a point a little over half the distance from eye to apex, then contracted into a narrow neck which is longer than broad, and has the posterior edge strongly reflexed. Clypeus slightly broader than long; sides straight, with a strong carina for entire length; anterior border truncate. Frontal area suboval in shape, with a longitudinal carina. Frontal laminae moderately elevated, approximating anteriorly. Mandibles rather slender, blade with five teeth. Antennae long and slender, scape extending a little beyond the mesoëpinotal impression, joints of flagellum subequal in length, all longer than broad, the anterior ones somewhat the thickest. Eye small, very convex, situated at posterior fourth of head. Thorax long and slender, the width contained four times in the length. Prothorax broadest at anterior third, constricted in front, sides evenly rounded; in profile very slightly convex. Promesonotal impression not deep. Mesonotum evenly rounded to near apex, where there is a strong transverse constriction; the sides from above strongly concave. Epinotum slightly over twice as long as broad, divided at anterior third by a broad transverse impression, which gives the profile the shape of a saddle; the declivity short,

with flattened surface, reflexed at base. Petiolar node thick; rounded above and at sides, a little broader than long; in profile rounded in front, nearly straight behind; the posteroventral surface of the petiole with a rounded projection. Ventral surface of mesothorax with an angulate tooth at anterior third. Gaster elongate oval, about two thirds as long as the thorax. Legs very long and slender.

Head sublucid, finely, densely, and evenly punctate. Thorax shining, minutely punctate. Epinotum finely striate, sublucid. Node sublucid, more coarsely striate transversely. Gaster shining, finely striolate.

Head without pubescence but with sparse, erect pile, antennae more coarsely pilose, funiculus pubescent, and with erect pile. Thorax, petiole, and node without pubescence, and but sparsely pilose. Gaster with scattered pubescence and sparse erect pile. Legs pilose, tibiae with a little pubescence.

Color dark ferruginous, the thorax lighter in color than the head or abdomen. Pile and pubescence white.

Described from several workers taken at Abuná. This is a very aberrant form, resembling at first sight one of the elongate American species of Dolichoderus. The long neck and the divided epinotum widely separate this species from those others which have been included in the genus Dendromyrmex.

Camponotus (*Dinomyrmex*) *agra* Smith has the occiput drawn out into a neck, and the head of the worker minor resembles that of *Dendromyrmex branneri*, but the thoracic structure is entirely different.

The following key will serve for the identification of the species of Dendromyrmex.

Form very long and slender; occiput drawn out into a narrow neck which is longer than broad; epinotum divided by broad transverse depressions into two portions (saddle-shaped in profile). *branneri* Mann

Form more robust; occiput not long; epinotum not divided....1

1. Thorax brown, or yellowish brown.....2
   Thorax black, or at least dark brown.....4
2. Gaster shining.....*chartifex* Smith
   Gaster opaque.....3
3. Head smaller; occiput faintly margined; color yellow. (British Guiana).....*chartifex* var. *felis* Mann
   Head larger; occiput not margined; color reddish. (Brazil) *chartifex* var. *mamoreënsis* Mann

4. More slender species; body black; thorax shining.....5
   More robust species partly brown; thorax subopaque.....6
5. With very sparse pile; tips of antennae brown; neck shorter; anterior border of clypeus convex.....*apicalis* Mann
   Abundantly pilose; tips of antennae black; neck longer. *madeirensis* Mann
6. Gaster shining.....7
   Gaster opaque.....8
7. Gaster black.....*traili* Mayr
   Gaster red.....*traili* var. *rufogaster* Mann
8. Gaster brown, with distinct punctation.....*nidulans* (Smith)
   Gaster black; punctation very fine.....*fabricii* Roger

PLATE 1.

PLATE 1.

Fig. 1. Eciton (Acamatus) legionis F. Smith subsp. crenulatum Mann. Worker.
2. Platythyrea meinerti Forel. Worker. Dorsal view.
3. Platythyrea meinerti Forel. Lateral view.
4. Rhopalopone relicta Mann. Worker.
5. Head of same from front.
6. Ectatomma (Gnamptogenys) tortuolosum F. Smith. Worker.
7. Ectatomma (Gnamptogenys) concinnum (F. Smith). Worker.
8. Ectatomma (Ectatomma) confine Mayr. Worker.
9. Neoponera (Neoponera) bakeri Mann. Worker.
10. Neoponera (Neoponera) carinulata (Roger). Worker.
11. Anochetus (Anochetus) bispinosus (F. Smith). Worker.

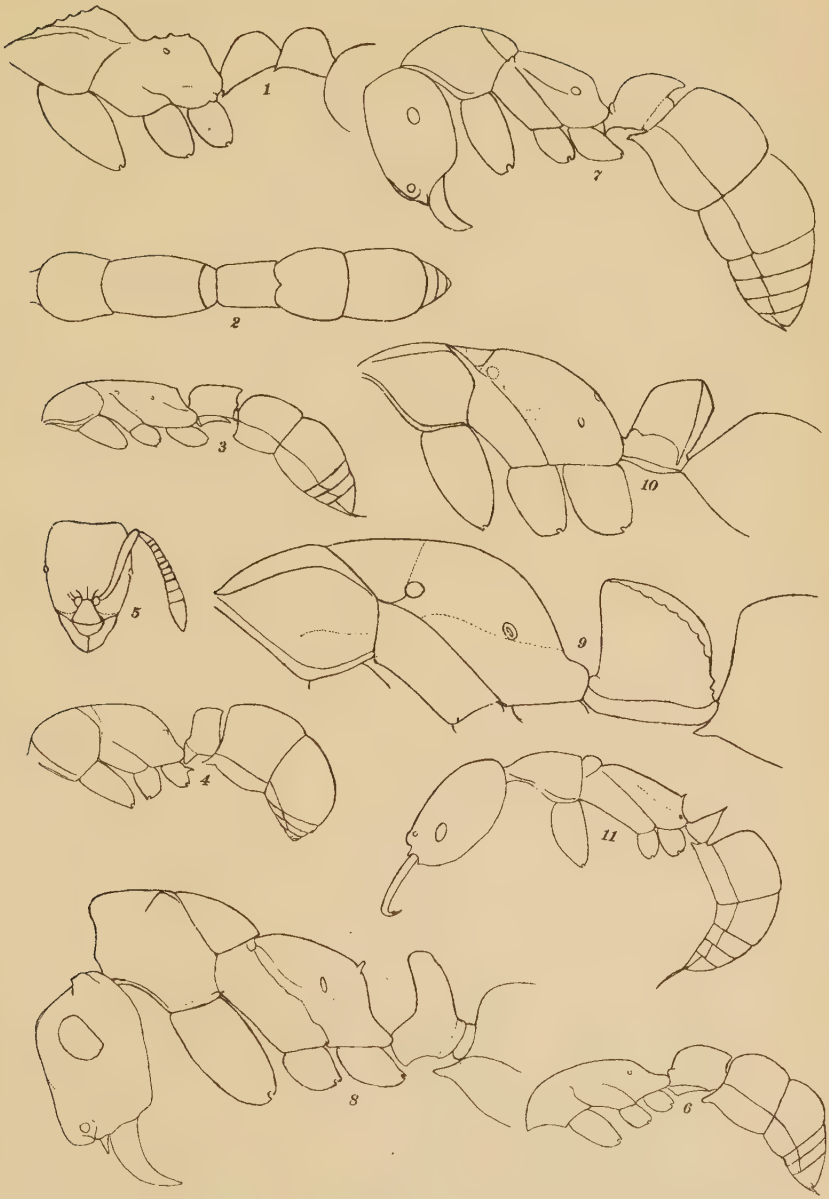

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PLATE 2.

PLATE 2.

Fig. 12. Belonopelta jeckylli Mann. Worker. Dorsal view.
13. Belonopelta jeckylli Mann. Worker. Lateral view.
14. Neoponera (Neoponera) cavinodis Mann. Worker.
15. Azteca schumanni Emery subsp. dubia Mann. ♀.
16. Azteca mülleri Emery subsp. terminalis Mann. ♀.
17. Dolichoderus (Monacis) tristis Mann. ♀.
18. Dolichoderus (Dolichoderus) imbecillus Mann. ♀.

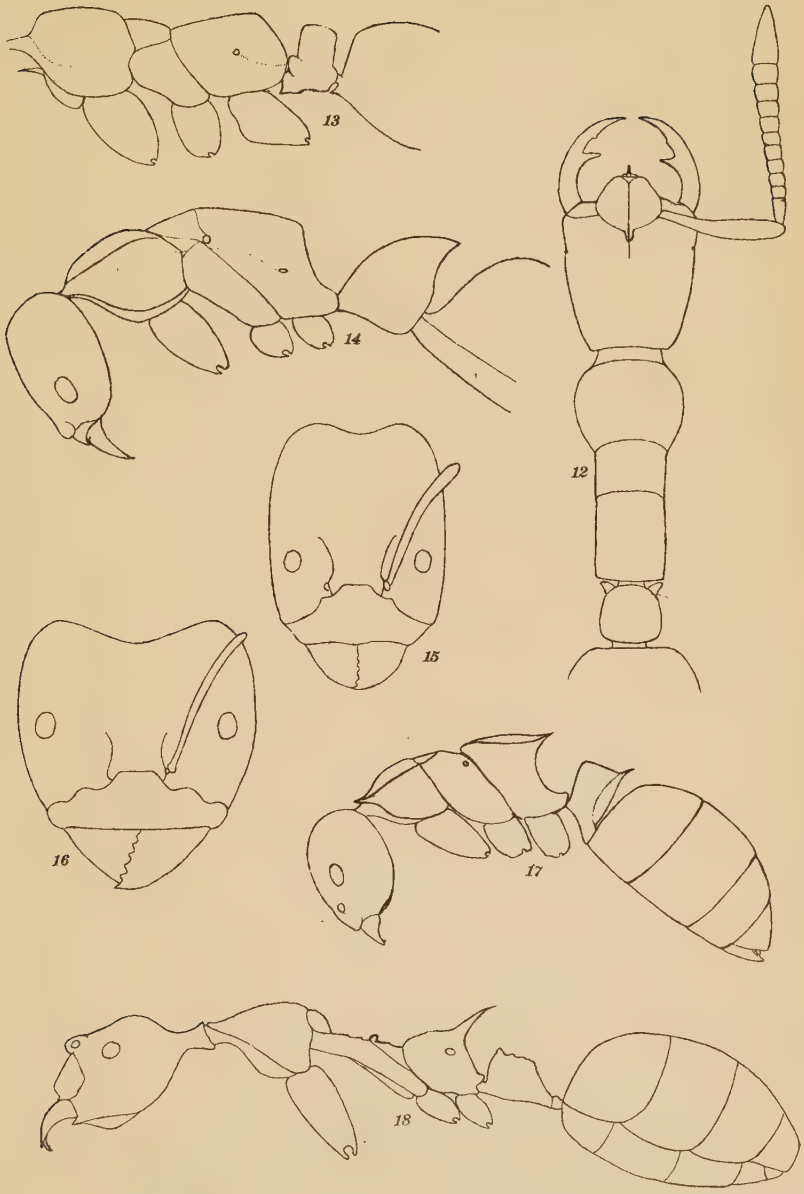

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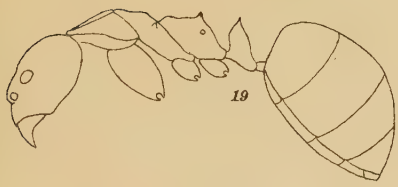
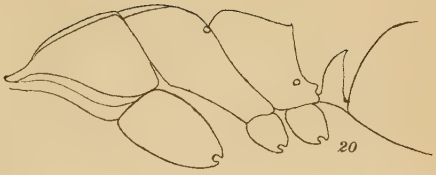
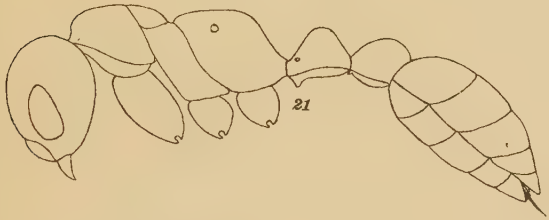
PLATE 3.

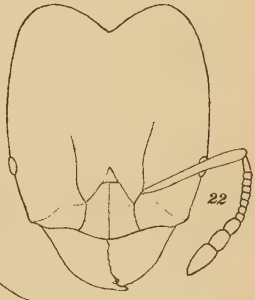
PLATE 3.

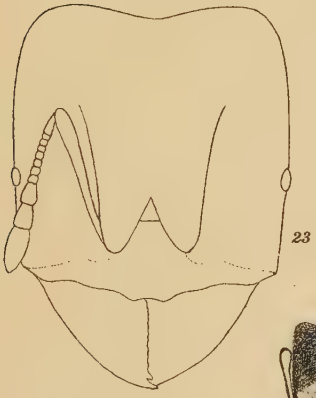
Fig. 19. Dolichoderus (Hypoclinea) ghiliani Emery. ☿.
20. Dolichoderus (Hypoclinea) lutosus F. Smith. ☿.
21. Pseudomyrma arboris-sanctae Emery. ☿.
22. Pheidole (Pheidole) carapuna Mann. Soldier.
23. Pheidole (Pheidole) wheeleri Mann. Soldier.
24. Pheidole (Pheidole) biconstricta Mayr subsp. burtoni Mann. Soldier.
25. Pheidole (Pheidole) colobopsis Mann. ♀.
26. Head of same from front.
27. Crematogaster (Crematogaster) heathi Mann. ☿.
28. Megalomyrmex wallacei Mann. ☿.

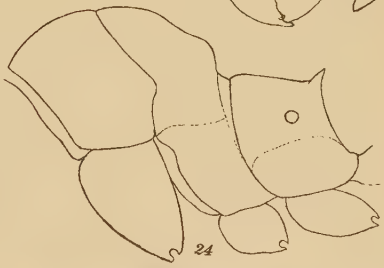


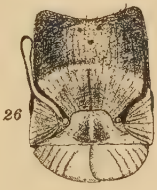


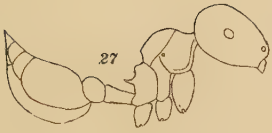












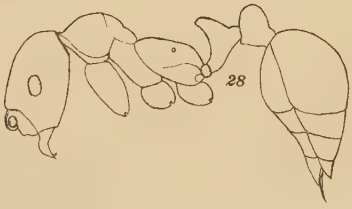


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PLATE 4.

PLATE 4.

Fig. 29. Monomorium (Mitara) subterraneum Mann. ☿.
30. Head of same from front.
31. Solenopsis geminata (Fabr.) subsp. medusa Mann. Soldier.
32. Myrmicocrypta foreli Mann. ☿, head from front.
33. Myrmicocrypta foreli Mann. ♀.
34. Myrmicocrypta foreli Mann. ☿.
35. Cryptocerus (Cryptocerus) complanatus Guérin. Soldier.
36. Leptothorax (Goniothorax) echinatinodis Forel subsp. spininodis Mayr. ☿.

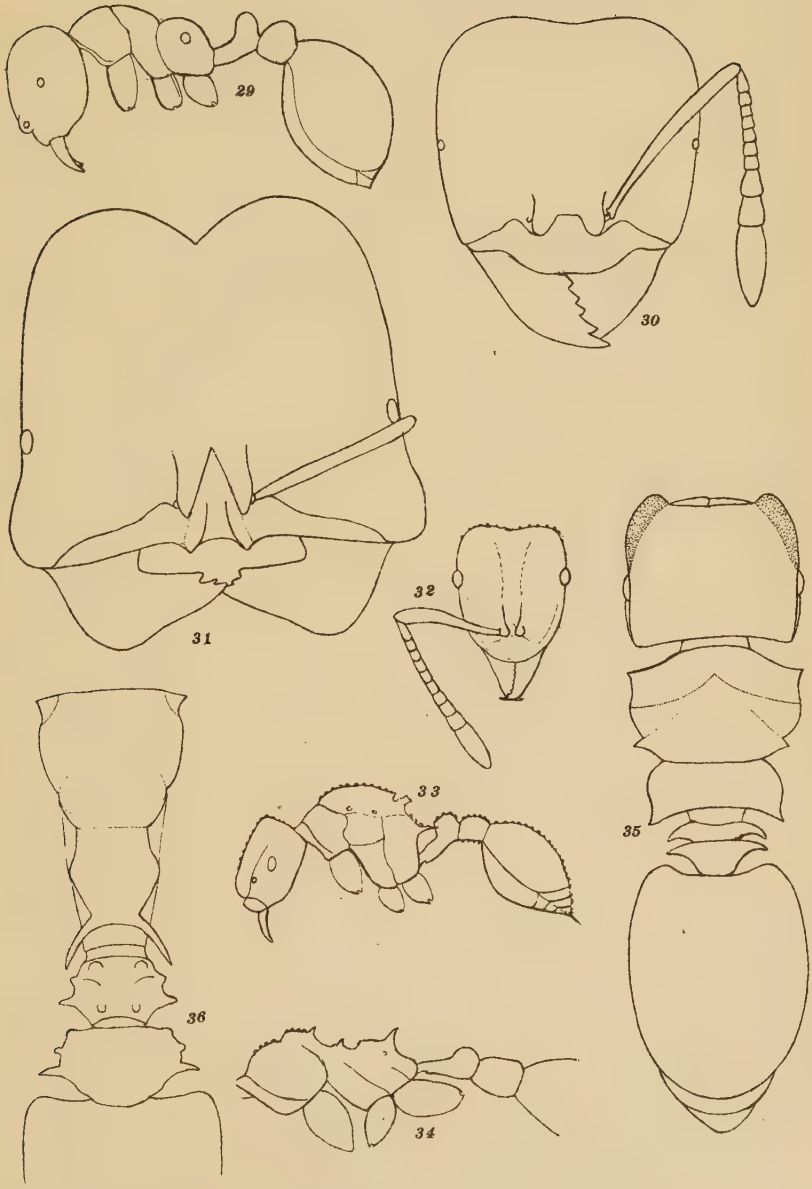
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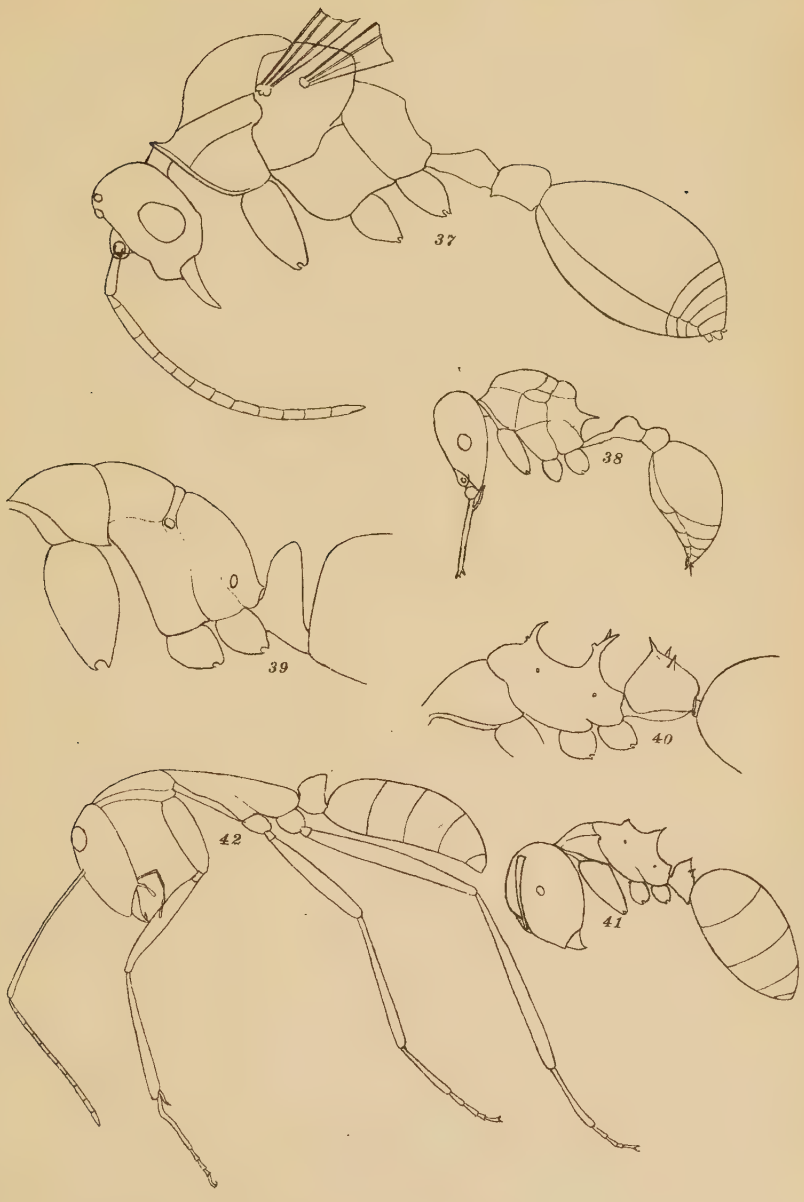
PLATE 5.

PLATE 5.

Fig. 37. Apterostigma branneri Mann. ♂.
38. Acanthognathus ocellatus Mayr. ♀.
39. Camponotus (Myrmothrix) rapax (Fabr.). ☿ major.
40. Camponotus (Myrmeurynota) heathi Mann. ☿ minor.
41. Camponotus (Myrmeurynota) heathi Mann. ☿ major.
42. Camponotus (Myrmomalis) depressus Mayr. ☿.



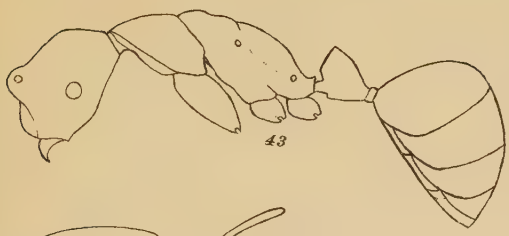
HELIOTYPE CO., BOSTON.

PLATE 6.

PLATE 6.

Fig. 43. Dendromyrmex apicalis Mann. Worker.
44. Camponotus (Myrmoturba) maculatus Fabr. var. abunanus Mann. Worker.
45. Camponotus (Myrmamblys) burtoni Mann. Worker major.
46. Camponotus (Myrmamblys) burtoni Mann. Head from front.
47. Dendromyrmex branneri Mann. Worker.
48. Camponotus (Myrmobrachys) adpressisetosus Forel. Worker major.
49. Camponotus (Myrmothrix) wheeleri Mann. Worker minor.
50. Camponotus (Myrmothrix) wheeleri Mann. Worker major.
51. Camponotus (Myrmothrix) wheeleri Mann. Worker minor.
52. Camponotus (Myrmoturba) maculatus Fabr. subsp. fryi Mann. Worker major.

Note. In the figures of *Camponotus* (*Myrmothrix*) *wheeleri* the points of insertion of the antennae are shown too far from the clypeus.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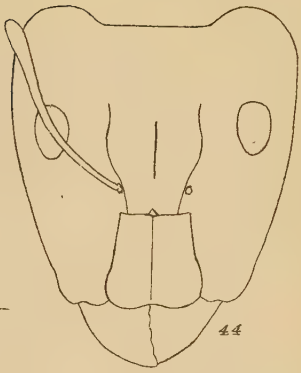
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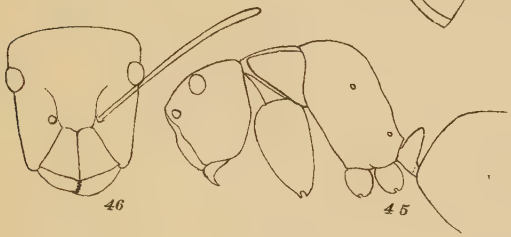
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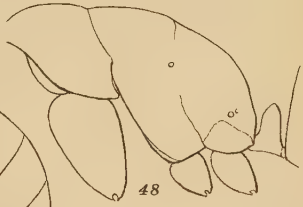
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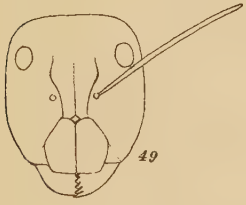
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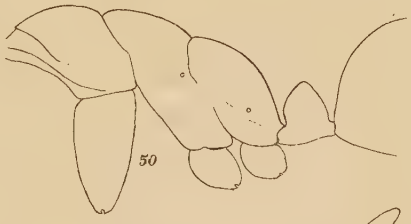
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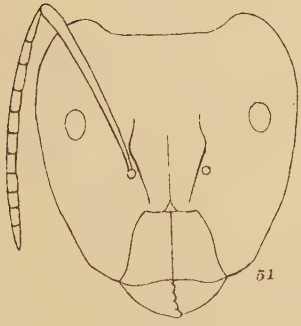
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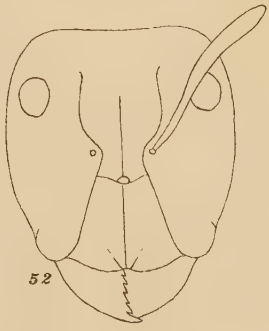
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PLATE 7.

PLATE 7.

Fig. 53. Platythyrea meinerti Forel. Full-grown larva.
54. Ectatomma (Ectatomma) quadridens (Fabr.). Larva.
55. Dinoponera grandis Guérin subsp. mutica Emery. Immature (?) larva.
56. Pseudomyrma rufa F. Smith. Female (deälated).

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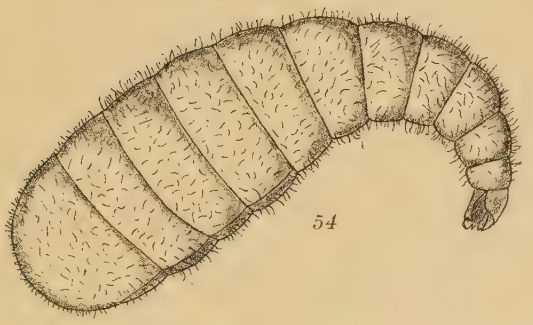

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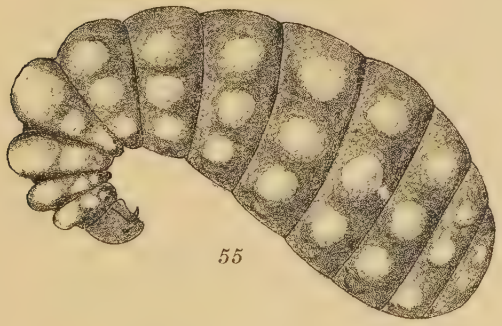

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The following Publications of the Museum of Comparative Zoölogy are in preparation:—

LOUIS CABOT. Immature State of the Odonata, Part IV.
E. L. MARK. Studies on Lepidosteus, continued.
E. L. MARK. On Arachnactis.
H. L. CLARK. The "Albatross" Hawaiian Echini.

Reports on the Results of Dredging Operations in 1877, 1878, 1879, and 1880, in charge of ALEXANDER AGASSIZ, by the U. S. Coast Survey Steamer "Blake," as follows:—

A. MILNE EDWARDS and E. L. BOUVIER. The Crustacea of the "Blake."
A. E. VERRILL. The Alcyonaria of the "Blake."

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieutenant Commander Z. L. TANNER, U. S. N., Commanding, in charge of ALEXANDER AGASSIZ, as follows:—

K. BRANDT. The Sagittae.
K. BRANDT. The Thalassicolae.
O. CARLGREN. The Actinarians.
R. V. CHAMBERLIN. The Annelids.
W. R. COE. The Nemerteans.
REINHARD DOHRN. The Eyes of Deep-Sea Crustacea.
H. J. HANSEN. The Cirripeds.
H. J. HANSEN. The Schizopods.
HAROLD HEATH. Solenogaster.
W. A. HERDMAN. The Ascidians.
S. J. HICKSON. The Antipathids.
E. L. MARK. Branchiocerianthus.
JOHN MURRAY. The Bottom Specimens.
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THEO. STUDER. The Alcyonarians.
—— The Salpidae and Doliolidae.
H. B. WARD. The Sipunculids.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of ALEXANDER AGASSIZ, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding, as follows:—

R. V. CHAMBERLIN. The Annelids.
H. L. CLARK. The Holothurians.
H. L. CLARK. The Ophiurans.
—— The Volcanic Rocks.
—— The Coralliferous Limestones.
S. HENSHAW. The Insects.
G. W. MÜLLER. The Ostracods.
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C. H. TOWNSEND. The Mammals, Birds and Fishes.
T. W. VAUGHAN. The Corals, Recent and Fossil.

PUBLICATIONS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT HARVARD COLLEGE.

There have been published of the BULLETIN Vols. I. to LIV. and Vols. LVIII. and LIX.; of the MEMOIRS, Vols. I. to XXIX., and also Vols. XXXI. to XXXIV., XXXVI. to XXXVIII., XL., to XLII., and XLIV.

Vols. LV. to LVII., LX. and LXI. of the BULLETIN, and Vols. XXX., XXXV., XXXIX., XLIII., XLV., to XLIX. of the MEMOIRS, are now in course of publication.

The BULLETIN and MEMOIRS are devoted to the publication of original work by the Officers of the Museum, of investigations carried on by students and others in the different Laboratories of Natural History, and of work by specialists based upon the Museum Collections and Explorations.

The following publications are in preparation:—

Reports on the Results of Dredging Operations from 1877 to 1880, in charge of Alexander Agassiz, by the U. S. Coast Survey Steamer "Blake," Lieut. Commander C. D. Sigsbee, U. S. N., and Commander J. R. Bartlett, U. S. N., Commanding.

Reports on the Results of the Expedition of 1891 of the U. S. Fish Commission Steamer "Albatross," Lieut. Commander Z. L. Tanner, U. S. N., Commanding, in charge of Alexander Agassiz.

Reports on the Scientific Results of the Expedition to the Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

Reports on the Scientific Results of the Expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer "Albatross," from October, 1904, to April, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

Contributions from the Zoölogical Laboratory, Professor E. L. Mark, Director.

Contributions from the Geological Laboratory, Professor R. A. Daly, in charge.

These publications are issued in numbers at irregular intervals. Each number of the Bulletin and of the Memoirs is sold separately. A price list of the publications of the Museum will be sent on application to the Director of the Museum of Comparative Zoölogy, Cambridge, Mass.

[Reprinted from Biological Bulletin, Vol. XXX , No. 5, May, 1916.]

THE NATURE OF THE POLYHEDRAL BODIES FOUND IN INSECTS.[1]

R. W. GLASER AND J. W. CHAPMAN.

Contents.

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3. Origin of the polyhedral bodies 373
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Introduction.

A very large group of lepidopterous larvæ is subject to a class of infectious diseases known as the "polyhedral diseases." Whether the organism concerned in their production is identical or not for all the species of insects affected must remain a matter of conjecture till further work allows us to venture an interpretation. One thing, however, is certain, namely that curious crystal-like structures called "polyhedral bodies" or "polyhedra" are always associated with the type of diseases we are here discussing. Although these polyhedra may vary considerably in size and somewhat in shape in the different species of insects, nevertheless, they are always specific for a certain type of malady.

Wahl, followed by Prowazek and Escherich, consider the polyhedral diseases as distinct and absolutely divorce them from the fungous, protozoan and bacterial affections of insects. We believe that the erection of a separate group to embrace all of the polyhedral diseases is an excellent plan and receives our sympathetic endorsement, for the reason that the confusion of all of the insect diseases is still common amongst entomologists. We venture to say that there are scarcely two entomologists in America who know the difference or similarity between any of the diseases expressed by such terms as Muscardine, Pébrine,

[1] Contribution from the entomological laboratory of the Bussey Institution in coöperation with the U. S. Bureau of Entomology (Bussey Institution No. 115).

flacherie, lethargia, maladie de morts-blancs, schlaffsucht, faulsucht, fettsucht, polyhedral disease, wilt, wipfelkrankheit, jaundice and gelbsucht.

We do not wish to dwell upon the differences or similarities between all of these maladies, but will confine ourselves solely to the group of polyhedral diseases under which are included the four commonest manifestations, viz., wilt, wipfelkrankheit, jaundice and gelbsucht. Wilt is the vernacular term used in America for the polyhedral diseases. It is a name suggestive of post-mortem aspects, but unfortunately a number of caterpillar diseases distinct from wilt on superficial examination also have a similar post-mortem appearance. Moreover, a number of diseases common to plant pathology are labelled with the same term. We do not think it wise to eliminate the name, however, for the reason that it has been used so long and "wilt" certainly means more to field entomologists and foresters than "polyhedral disease" which is only significant to laboratory workers. The term "Wipfelkrankheit," which is used for a similar affection of nun moth caterpillars in Germany, is a very suggestive name for the reason that when the animals are in the last stages of the disease, they congregate in masses at the tops of the trees or "wipfeln" and die hanging by their prolegs. The name "Wipfelkrankheit" has the further advantage in that it is not applied to any other plant or animal disease. "Gelbsucht" or "jaundice" are terms used to designate a polyhedral disease in silkworms. The two terms are descriptive of the clinical picture of the diseased worms and are not used for any other affection known to pathology.

The larval stages of the following species of lepidoptera have been examined by us and found to be susceptible to the polyhedral diseases. Animals which can only be infected experimentally have been omitted, *i. e.*, the list comprises only those which besides being capable of experimental infection also have the disease or diseases in a state of nature.

I. Saturnidæ.

1. *Hemileuca maia* Drur.

II. Arctiidæ.

2. *Apantesis virgo* Linn.

III. Noctuidæ.
  3. *Leucania unipuncta* Halw.
  4. *Noctua clandestina* Harris.
  5. *Autographa brassicæ* Riley.
IV. Lymantridæ.
  6. *Porthetria dispar* L.
  7. *Lymantria monacha* L.
  8. *Orgyia leucostigma* S. and A.
V. Lasiocampidæ.
  9. *Malacosoma americanum* Fabr.
  10. *Malacosoma disstria* Hubn.
VI. Bombycidæ.
  11. *Bombyx mori* L.
VII. Dioptidæ.
  12. *Phryganidia californica* Packard.
VIII. Pieridæ.
  13. *Colias philodice* Godart.

From a perusal of the above list it will be seen that the polyhedral diseases are very widely distributed and affect some of our most important economic insects. We have estimated that epidemics of polyhedral diseases at certain times kill off from 30 to 70 per cent. of some of our most noxious pests. This is especially true, as we have found in connection with our studies on the gipsy moth, tent caterpillars and army worms. The polyhedral diseases contribute much more to the control of certain of our noxious caterpillars than the combined efforts of all their hymenopterous and dipterous parasites. Therefore, we believe that these diseases merit a serious consideration from all points of view.

The Polyhedral Bodies.

Caterpillars dead from wilt are usually found on some elevated place hanging by their prolegs. Dead nun moth caterpillars are found hanging from the very highest branches of a conifer, dead gipsy moth caterpillars are found hanging anywhere on the trunk of a tree or on a branch; the favorite dying places of the American tent caterpillars being usually in close proximity to the nest on the branches of an apple or cherry tree. The army

worm seeks the tip of a grass blade and succumbs thereon. An innate desire to reach an elevated place on their favorite food plant always seizes the diseased insects prior to death. We have never observed animals in the last stages of wilt descend their food plants. So far we are unable to offer any explanation which would satisfactorily assist in analyzing this ascending instinct. A short time after death, the animals become deliquescent. At the slightest touch the skin ruptures and a dark brown liquid oozes out. In some species such as the American and forest tent caterpillars this liquid is pink shortly after death and becomes dark brown later. The corpses will be practically odorless if they have hung but a short time and before septic bacteria have gained a foothold.

If some of the brown liquid from a dead caterpillar is examined microscopically with a high-power dry or oil-immersion lens, it will be found to contain, besides the elements of disorganized tissues, myriads of polyhedral bodies of various sizes. (Fig. 1, Plate 1.) Certain polyhedra have been found to measure $\frac{1}{2}\,\mu$ and less in diameter while still others reach the size of $15\,\mu$. The average polyhedron of the gipsy moth caterpillar measures $3.4\,\mu$ in diameter. The bodies in this species are larger than those in any other form we have hitherto examined. The average size of nun moth caterpillar polyhedra measure $2.65\,\mu$ in diameter; those of the forest tent caterpillar $2.6\,\mu$ and so on until we come to *Phyrganidia californica* and the tussock moth caterpillars in which the average diameter has been found to be $1.6\,\mu$ and $1.5\,\mu$ respectively. Thus it is seen that the average polyhedron varies greatly in size in the different species. As stated previously the sizes of the polyhedra within one species or even within one animal (gipsy moth: $\frac{1}{2}\,\mu$–$15\,\mu$) varies also. There exists a striking similarity between the shapes of these bodies in the different species but some variation within a particular species or even within the same animal can be observed. In general the form is that of a polyhedron with more or less rounded angles. They never assume the shape of a perfect sphere, and an actual geometric outline has never been observed except in the silk worms where almost perfect octahedra are found. The polyhedra are highly refractive, and on focusing are seen to have a

denser center differentiated from a somewhat lighter periphery. Sometimes within the bodies concentric layers like those of an onion are observable. Often two polyhedra are seen adhering to one another as if in the act of dividing, but an actual division in a hanging-drop has never been observed. When pressure is applied to the cover glass, the polyhedra crack very readily into a number of pieces, and often without the application of pressure the same fragmentation may be observed to occur somewhat more slowly. In the latter case a notch appears at one side of the polyhedron which gradually lengthens into a line progressing slowly toward the other side, much like the cracking of ice. Usually before the line has completely separated the two halves other lines appear, and soon the entire polyhedron is divided into a number of pieces, which may separate or may stick together in a rosette-like fashion. At no time was anything observed to come out of the polyhedra when they cracked in this manner. If the cover glass is moved while applying a little pressure, one half of the polyhedron may sometimes be folded upon the other half without the cracks appearing, showing that it is composed of a tough substance and is not at all brittle like inorganic crystals.

The only objects in a fresh preparation with which one could possibly confuse the polyhedra are the fat globules and urate crystals, but with a little practice these may be readily distinguished. Fat globules are perfectly spherical and are therefore unlike the polyhedral shape of the bodies in question; but when in doubt, Sudan III was used, for in this stain the fat globules become red, while the polyhedra remain colorless. The urate crystals are often more acutely angular or are of an entirely different shape from the polyhedra and are frequently traversed by radiating lines.

Besides polyhedral bodies, fat globules, and urates, a smear from a newly "wilted" caterpillar contains cellular débris, hairs and pigment granules. The pigment granules must not be confused with bacteria, for many of them superficially resemble these organisms very closely. When a preparation is dried, mounted, and examined under oil, the pigment granules of the gipsy moth may easily be confused with small micrococci, owing to the fact that they are usually arranged in pairs. As a

matter of fact, a smear made from a recently wilted caterpillar is almost devoid of bacteria, and in many cases none at all can be found. If bacteria are present, they have escaped into the body cavity through rupture of the intestine and bear no direct etiological relation to the disease.

In fixed and stained smears a number of things can be demonstrated to advantage within the polyhedra. Fixation was accomplished either by passing the preparation through a flame or by placing it in absolute alcohol for a few minutes. The smears were then stained in Giemsa's solution for 12 hours or were stained for a shorter period with one of the following dyes: Methylene blue, trypan blue, gentian violet, carbol fuchsin, Bismarck brown, or iron hæmatoxylin. When iron hæmatoxylin was used, the preparation was first mordanted in a 4 per cent. ferric-alum solution for two or three hours. After staining, the preparations were sometimes quickly passed through the alcohols to xylol before mounting. This not only clears everything, but dissolves away all the fat on the slide and thus increases the transparency of the preparation. Gipsy moth polyhedra are rather resistant to stains in general and usually color along the periphery only, unless the stain is applied for a long time. When this is done one may succeed in staining the entire polyhedron, especially after the use of some mordant like ferric alum before hematoxylin or anilin water before gentian violet. Steaming the preparation with a stain like carbol fuchsin has also given good results. When properly stained, one of three conditions is observed: First, the polyhedral bodies are uniformly stained so that nothing can be detected within them; or second, a uniformly darker staining central mass can easily be differentiated from an almost unstained outer substance; or, third, many little refractive, reddish granules are seen within the polyhedra. An actual differentiation between what might be interpreted as nuclear and cytoplasmic material within the polyhedra never occurs. Therefore, in accounting for the staining reactions we believe that at times the polyhedra have a central granular or homogeneous substance easily distinguishable from an outer tougher substance which is more resistant to the dyes. This varies a great deal, however, and sometimes the periphery takes the

stain more readily than the underlying strata. From these staining reactions it becomes apparent that the polyhedra are complicated in structure, and do not therefore differ essentially from what Bolle and Prowazek found to be true of the silkworm polyhedra. Our observations on the staining reactions also show that morphological studies do not enable us to regard the polyhedral bodies as organisms. We believe that the polyhedra are protein degeneration-products of the disease. The staining reactions have demonstrated that they are not simple crystals, but complicated in structure, and have a tough outer layer. Consequently, and for a number of other reasons, we do not believe them to be true crystals and therefore choose to call them pseudo-crystals. The variations in their staining reactions which one obtains at times can well be accounted for by assuming that one is dealing with different stages in the synthetic process of pseudo-crystals. Another matter militating against the idea that the polyhedra are organisms is the fact that Glaser ('15) and Chapman and Glaser ('16) have experimentally demonstrated the possibility of infecting healthy gipsy moth caterpillars with wilt material from which the polyhedral bodies were removed by passing the virus through Berkefeld Grade "N" candles. We have shown that wilt is caused by a filterable virus and believe that the polyhedra arise as a reaction against the invasion of this virus.

Origin of the Polyhedral Bodies.

Studies on sectioned gipsy moth, army worm and tent caterpillar material have shown that the polyhedra originate within the nuclei of the hypodermal, fat, tracheal matrix, and blood cells. (Fig. 2.) In the true army worm, however, polyhedra are at times formed within the nuclei of intestinal epithelial cells. We have been utterly unable to find the bodies within the nuclei of muscle tissue, Malpighian tubes, ganglia, nerves, œnocytes, salivary glands, gonads and within the intestinal epithelial cells of all forms except the true army worm.

The formation of the polyhedral bodies within the nuclei of the four tissues above mentioned and the visible changes taking place within these nuclei may be described as follows: The first

indication of a diseased nucleus seems to consist in the flowing together of the chromatin into a lump in the middle. Then out of the achromatic substance the polyhedra arise as very minute individuals. (Fig. 2, Plate I.) They gradually increase in size and probably most of the chromatin is also used up during the synthetic process. As the polyhedra grow, they become more and more refractive, stain with difficulty, and the nucleus becomes hypertrophied. The late stages of these hypertrophied nuclei are more than twice as large as the largest normal nucleus. (Fig. 2, Plate I, and 3, 4 and 5, Plate II.) This swelling of the nucleus is due to the increase in size of the polyhedral bodies which stretch the nuclear membrane. During the earlier stages of the disease the polyhedra are somewhat rounder than the larger ones found later on prior to death. This can be accounted for by the fact that, as the polyhedra grow, they become so closely packed within a nucleus that they press upon one another and thus the more or less polygonal shape is produced. As the polyhedra grow and become more refractive the remains of the chromatin lump disappears and there remains simply the nuclear membrane enclosing the polyhedra. (Fig. 2, Plate I, and 3, Plate II.) Finally the nucleus disintegrates, and the polyhedra are found free in great numbers in smears of dead caterpillars. (Fig. 6, Plate II.) We believe (and this belief is based on morphological, chemical and experimental evidence) that the polyhedral bodies are degeneration-products of the disease—products of nuclear disintegration. This view may not seem so improbable if one reviews some of the literature dealing with a few of the diseases in higher animals.

Hydrophobia (Rabies).

In 1903, Negri described certain bodies occurring in the nervous system of animals dying of rabies. The bodies seem to be specific to the disease, and are of great assistance for diagnostic purposes. The Negri bodies vary in size, measuring from .5 to 25 μ. They are round, oval or angular in outline and are found in the protoplasm of the nerve cells and their processes. The bodies occur in all parts of the nervous system, but are most common in the Purkinje cells of the cerebellum and especially in the cells of the cornu Ammonis. The virus of hydrophobia passes through

the coarser Berkefeld and Chamberland filters, and these filters exclude the Negri bodies. The most generally accepted view at present is that the Negri body is a cellular reaction against the invasion of the filterable virus. The virus of hydrophobia has not been cultivated.

Variola and Vaccinia (Smallpox and Cowpox).

In 1892 Guarnieri described certain cellular inclusions in variola and vaccinia which are specific for these two diseases. The bodies are from 1–8 μ in diameter, and round, oval, or sickle-shaped. They lie in the cellular spaces, often in close proximity to the nucleus, and can be demonstrated in vaccine pustules as well as in the experimental lesions produced in the rabbit's cornea. The virus of variola and vaccinia passes through the coarser porcelain (Chamberland) filters. Most authorities regard the Guarnieri bodies as the effect of a specific reaction of epithelial cells against the virus. The virus has not been cultivated.

Trachoma.

In trachoma certain granules are found in the cytoplasm of the inflamed epithelial cells which cover the conjunctiva. Bodies similar to the trachoma bodies have also been found in other inflammations of the conjunctiva, and are therefore thought not to be specific of trachoma. The trachoma bodies are regarded as the product of mucous secretion under pathological conditions. The virus passes through Berkefeld filters. It has not been cultivated.

Cellular inclusions not regarded as parasitic by some workers have been found in a number of other diseases. In scarlet fever cellular inclusions occur in the skin lesons; in foot and mouth disease inclusions are found in the vesicles; in fowl pest inclusions are found in the brain and in epithelioma contagiosum or fowl diphtheria in the epithelium. Cytoplasmic inclusions accompanying many of the diseases of higher animals, and regarded as non-parasitic in most cases are not at all uncommon, but we have been unable to find any account in the literature of vertebrate diseases which are accompanied by the formation of *nuclear* inclusions as is the case with the polyhedral diseases of insects.

Bio-chemical Observations on the Polyhedral Bodies.

According to Tubeuf, Krassilschtschik, Prowazek, Wahl, Wolff, Glaser and Chapman the polyhedral bodies are regarded as being reaction products; towards bacteria (Tubeuf, Krassilschtschik) or towards Chlamydozoa (Prowazek, Wolff) or towards an unknown virus (Wahl) or towards a filterable virus (Glaser and Chapman). According to Bolle, Fischer, Marzocchi, and Knoche the polyhedral bodies are stages of a protozoan; according to Escherich and Miyajima they are bearers of an unknown virus.

It seems that the views are very diverse as regards the true nature of the polyhedra. For this reason it was thought advisable to submit some of our bio-chemical work on this subject in further support of our contention, obtained from morphological and experimental studies, that the polyhedra are merely organic degeneration-products of the disease.

During the gipsy moth season great quantities of diseased material can be obtained. For this reason all of the bio-chemical investigations were performed with gipsy moth polyhedra. These bodies are heavier than water and consequently can be obtained in bulk by centrifuging aqueous emulsions of diseased material. By repeated washing, filtering and centrifuging most of the fat, cellular débris, etc., can be eliminated. After this treatment the polyhedra were always washed with ether in order to free them from any possible remnants of adhering fat. Thorough attention to this cleansing operation will yield polyhedra in a fairly pure state for chemical tests. The material was allowed to dry naturally in the centrifuge tube, after which the lump that formed at the bottom could be loosened and transferred to a mortar where it was pulverized. This pulverization if done gently does not crack or injure the polyhedra in any way. After this procedure the mass of polyhedra look very much like pulverized chalk. It is comparatively easy to obtain 2 or 3 grams of polyhedra from about one or two hundred caterpillar cadavers.

As the polyhedra do not blacken with osmic acid, and do not stain with Sudan III., it seems unlikely that they contain fat. They stain with picric acid, however, and this gave us the clue to their possible protein nature. The color tests for dry proteins

were then applied and we obtained positive reactions with xanthoproteic, Millon's, biuret, Adamkiewicz's and Lieberman's tests. It was next found necessary to obtain the polyhedra in solution so that the various coagulation or precipitation tests could be performed.

Before testing the solubility of the polyhedra in various reagents they were first rubbed energetically in an agate mortar with the addition of a little sea sand. This grinding was found necessary for the reason that the outer surface of the bodies is composed of more resistant material than the underlying strata. By grinding with sea sand the polyhedra are fragmented and this offers more delicate surfaces to the action of the reagents.

The polyhedra were found to be insoluble in hot or cold water, alcohol, chloroform, ether, or xylol. They dissolve readily in strong acids and alkalies, but these reagents were thought to produce too great a hydrolytic cleavage of the protein molecule, and since we did not wish to alter our material to any appreciable extent a number of milder reagents were tried. Moreover, from the standpoint of the classification of proteins it is important to determine just what will and what will not dissolve the material.

The following solubility tests were performed. Two grams of ground polyhedra were divided into four parts. To ½ gram water was added; to ½ gram .5 per cent. and to another ½ gram 2 per cent. NaCl solution, and to the fourth ½ gram 10 per cent. Na_2CO_3 were added. The tests were kept over a water bath for 13½ hours at a temperature varying between 55° and 58° C. At the end of this time the solutions were filtered and the various tests for soluble proteins applied. All of the tests (acetic acid, nitric acid, cupric sulphate, mercuric chloride, acetic acid with potassium ferrocyanide and ammonium sulphate) were negative showing that nothing went into solution.

Two grams of polyhedral material were again divided into four parts and treated respectively with H_2O, .5 per cent. and 2 per cent. NaCl and 10 per cent. Na_2CO_3. The tests were placed over a small direct flame for two hours. At the end of this time the solutions were filtered and the tests for soluble proteins applied. Negative tests were obtained with the water and salt

solutions. The material treated with the 10 per cent. Na_2CO_3 solution gave slight coagulation tests with acetic and nitric acids showing that a small amount of protein went into solution. The polyhedra treated with the carbonate were examined microscopically and it was found that some fragments had partially dissolved while most of the polyhedra, which had apparently resisted fragmentation in the mortar had swollen to double their normal size.

Concentrated HCl (37 per cent.) used both hot and cold seems to dissolve the polyhedra with difficulty. The solubility of the bodies in boiling HNO_3 seems to lie between 15 and 20 per cent. We began with 4 per cent. HNO_3 in which the polyhedra are not affected and worked up to 31 per cent. HNO_3 in which they dissolve instantaneously on boiling. The fact that the liquid clears when some of the lower percentages of HNO_3 are used is not sufficient evidence that all of the polyhedra have been dissolved. For this reason the solubility of the bodies towards the acid was checked by microscopical examinations.

$(NH)_4OH$ does not seem to affect the polyhedra, but the other alkalies such as KOH and NaOH dissolve them readily. It was found that as low a percentage as 1/16 per cent. NaOH will dissolve polyhedra if they are boiled in the solution. For convenience 2 per cent. NaOH was used for the following tests. Two grams of ground bodies were dissolved in the alkali by means of heat. The solution was then dialyzed in order to get rid of the alkali. The dialysis was usually complete after 24 to 48 hours. At the end of this procedure the proteins remain in solution (*i. e.*, on dissolving in alkali, after which, although the alkali be removed, the polyhedra proteins remain soluble) and the tests for soluble proteins can be applied. We obtained positive reactions with acetic acid, nitric acid, cupric sulphate, mercuric chloride, acetic acid with potassium ferrocyanide and ammonium sulphate.

It might be well to mention that the percentages of NaOH used were accurate and the material pure. In making up the solution we did not rely on the so-called purity of the hydroxide sticks, but always eliminated every trace of Na_2CO_3 by precipitation with $Ba(OH)_2$.

After determining that the polyhedra are protein in nature it

was next thought advisable to ascertain whether or not they are nucleoproteins. It seemed likely that this would be the case for the reason that they are formed in the nuclei of certain tissue cells. Two grams of whole (unrubbed) polyhedra were digested for one week in artificial gastric juice. After this time a microscopic examination failed to reveal any polyhedra. Theoretically, everything should have been decomposed excepting the nucleins which have a high phosphorus content. At the end of one week's digestion the material was filtered through and dried on ash free filter paper. The paper containing the residue was then cut into fine pieces and put into a platinum crucible with an oxidizing mixture (Na_2CO_3 (2 parts) + KNO_3 (1 part)). The material was slowly ignited and the residue dissolved in weak HNO_3. This solution was then warmed with the addition of some NH_4NO_3 in order to make the expected precipitate less soluble. Lastly 5 per cent. molybdic acid was added. The material was placed in an incubator and on standing a pronounced yellow precipitate (ammonium-phospho molybdate) was formed.

On the basis of this and the other tests described the polyhedra meet all of the requirements of the nucleoproteins. Nucleoproteins give all the color reactions, are soluble in water containing a small amount of alkali (1/16 per cent. in case of polyhedra) and are precipitated from this solution by acetic acid. The nucleins which have a high phosphorus content are not decomposed by gastric juice, and are obtained as an insoluble residue after the artificial digestion of nucleoproteins with pepsin.

Since iron is an element known to be contained in chromatin it was further thought advisable to determine whether the polyhedra during their synthesis from the chromatin and other substances in the nuclei embodied any iron. It will be needless to go through all the details of the analysis. Suffice it to say that every precaution to prevent iron contamination from water, air, etc., was used. Reagents known to be free from iron contamination were employed. Furthermore, the polyhedra were not rubbed with sand for fear of introducing iron in this manner. .0988 of a gram of polyhedra were used and .00049 of a gram of iron was found.

On dissolving polyhedra in alkali and after dialyzing away

the alkali, three fractional precipitations with magnesium sulphate or sodium chloride can be obtained. Whether this means that the polyhedra are composed of three separate proteins or three groups of proteins, we are not prepared to say. The three precipitates, however, do demonstrate that the polyhedra are complex and not at all simple, a fact which does not seem strange when one reflects on the complexity of cellular or nuclear material in general.

As stated previously we regard the polyhedra as degeneration products formed during the course of the disease in the nuclei of certain tissue cells. The bodies are nucleoprotein crystal-like (pseudo-crystalline) aggregates. The idea suggested itself to us that it might be possible to dissolve the polyhedra and recrystallize them again after dissolution. If this should prove to be possible, it would militate seriously against the views held by Bolle, Fischer, Marzocchi, Knoche, Escherich and Miyajima that the bodies are organisms or the stages of an organism. Our experimental attempts at recrystallizing the polyhedra are a bit varied and so we do not wish to overemphasize our results as yet, but submit them with a full appreciation of their preliminary value.

Polyhedra were dissolved in 2 per cent. NaOH by heating. The process of dissolution was followed by an examination of samples microscopically, and when traces of the bodies could no longer be observed, the material was evaporated over a water bath and examined before it became entirely dry. Besides long Na_2CO_3 crystals we found many small and large bodies which resembled polyhedra. As a check we evaporated ordinary 2 per cent. NaOH, but we could not find the polyhedra-like crystals obtained with the protein solution. This seemed to be a result which offered possibilities, so we proceeded more carefully with another experiment.

Two grams of polyhedra were dissolved by heating in 2 per cent. NaOH. This solution was filtered and washed with ether in order to rid the material of any traces of fat. The ether was then eliminated by means of a separating funnel. The solution was next dialyzed to get rid of the alkali and a few protein tests were performed with some of the solution just to convince our-

selves of the presence of proteins. This protein solution freed from the alkali was now slowly evaporated. On partial evaporation, we found beautiful single and double crystals which simulated the polyhedra very closely. If the material is evaporated completely it is difficult to find the crystals owing to the presence of coagulated and other protein material which hides them. If one shoots water under the cover-slip, however, the crystals again become visible just as soon as the coagulated sediment softens and becomes transparent. This fact that a coagulated residue remains shows that the entire protein material contained in the original polyhedra is not used during the formation of these new crystals. The majority of the crystals produced in this way simulate polyhedra very closely, but some are rounder and larger. Double forms are very common and are absolutely indistinguishable microscopically from ordinary polyhedra. The staining reactions of the crystals are similar to those of the polyhedra and Millon's reaction is identical. We have as yet not obtained a sufficient amount of these new crystals to submit them to all of the protein tests applied to the polyhedra. The crystals are not quite as stable as the polyhedra. They seem to lack the more resistant outer layer and therefore are more easily soluble in alkali and other reagents. For this and other reasons we do not claim to have reproduced typical polyhedra after their disintegration, but we firmly believe that the results are suggestive. It seems unreasonable, after submitting proteins to the violent hydrolytic action of both heat and alkali, to expect to reproduce the identical proteins. However, in the material under consideration, there seems to be a tendency for this particular protein or group of proteins to crystallize out in the shape characteristic of the polyhedra. These observations seem to support our view that the polyhedra are merely degeneration-products and not some inexplicable, unclassifiable organisms as supposed by many workers. An organism certainly could not be dissolved and its original form again reproduced or very nearly reproduced on evaporation.

So far we are unable to obtain the crystals after the dissolution of the polyhedra at every trial. Out of possibly ten trials, one usually succeeds four or five times. Undoubtedly some condition

of which we are at present ignorant is responsible for the frequent failures. We have performed a sufficient number (15) of these recrystallization experiments, however, to warrant a report of the results.

Crystallizable proteins are, of course, not uncommon. Hæmoglobin is perhaps the best known example in animals and the aleurin grains a well known example in plants. By fractional precipitation with magnesium sulphate or sodium chloride two or three separate crystalline proteins can be obtained from the albumen of the hen's egg. In insects, by the evaporation of blood with a trace of acetic acid, beautiful protein crystals can be obtained, different in every species.

Our view regarding the nature of the polyhedral bodies may therefore be summarized as follows: During the course of the disease the virus disintegrates the nuclear material in such a way that crystal-like bodies called polyhedral bodies or polyhedra are synthesized out of the disintegrating proteins. Just how the process from nuclear material to polyhedra takes place is at present unknown. At any rate, from our morphological observations, experimental infection data (published elsewhere) and from our chemical studies here presented, it seems clear that the polyhedra are nucleoprotein degeneration-products and not organisms responsible for a series of insect diseases.

Summary.

1. Polyhedral bodies are found in many different species of lepidopterous larvæ.

2. The bodies are specific for a certain type of disease.

3. The polyhedra vary in size in the different species.

4. There exists a striking similarity in shape between the polyhedra found in different species.

5. The polyhedra are structurally complicated.

6. They arise in the nuclei of certain tissue cells.

7. Cytoplasmic inclusions are found in certain diseases of higher animals.

8. Nuclear inclusions have not been known previously.

9. The polyhedra are nucleoprotein crystal-like degeneration-products and not organisms.

10. The polyhedra contain iron and phosphorus.

11. On dissolving polyhedra in alkali and after dialyzing away the alkali and evaporating the protein solution crystals are obtained which simulate the original polyhedra.

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PLATE I.

FIG. 1. Photomicrograph of a smear showing free polyhedra.

FIG. 2. Photomicrograph showing various stages during the formation of polyhedra in tissue nuclei of a gipsy moth caterpillar. × 720.

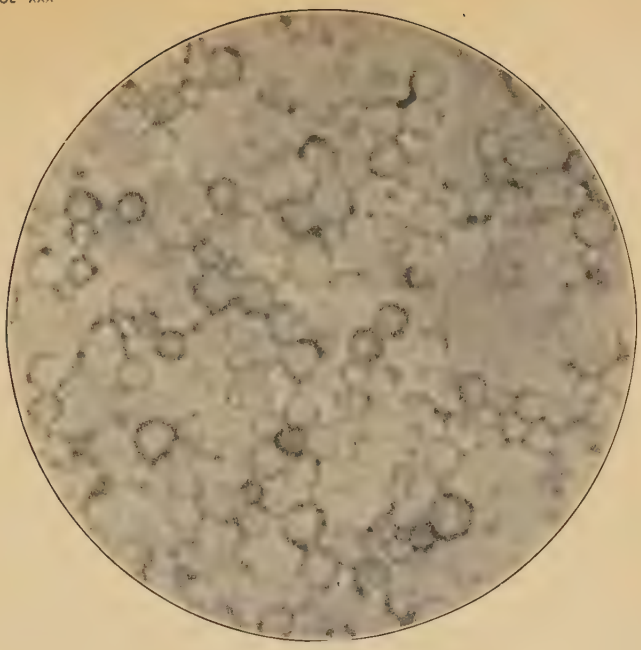

FIG. 1.

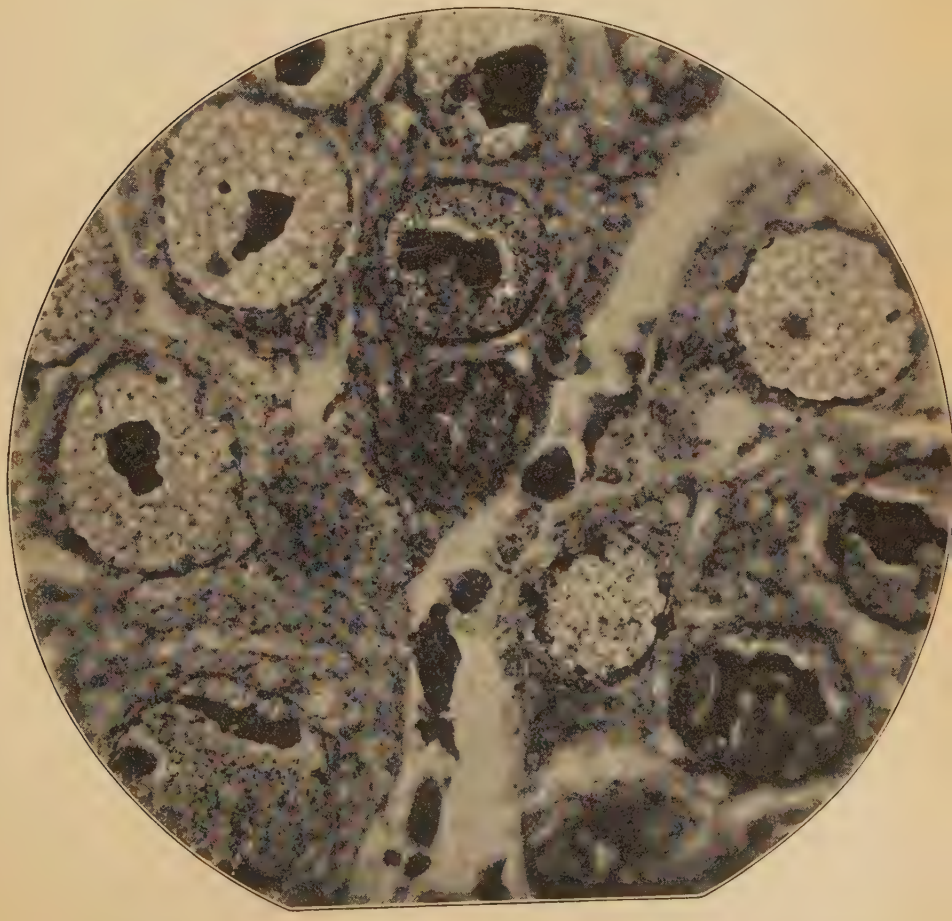

FIG. 2.

PLATE II.

FIG. 3. Photomicrograph of army worm tissue showing fully developed polyhedra in nuclei of fat cells. × 300.

FIG. 4. Photomicrograph of army worm tissue showing normal hypodermal, fat, muscle and blood cells. × 300.

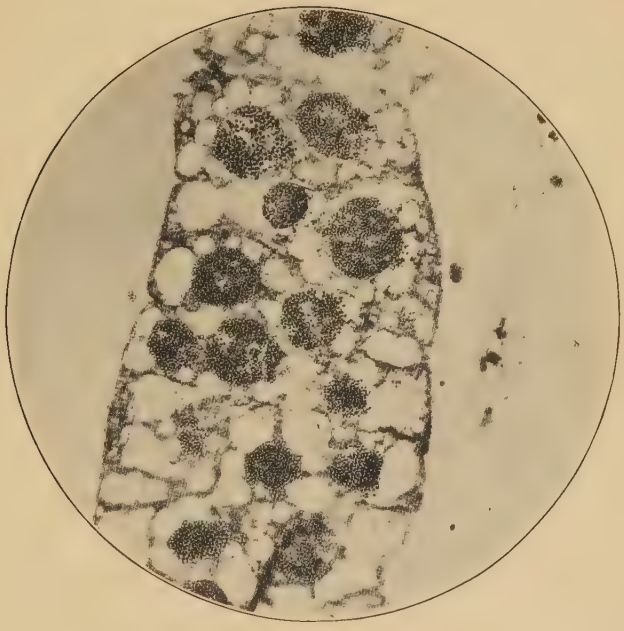

FIG. 3.

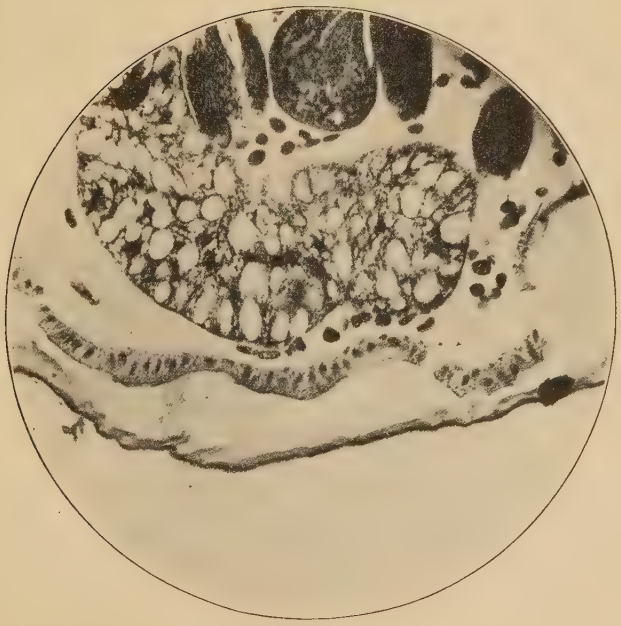

FIG. 4.

PLATE III.

FIG. 5. Photomicrograph of army worm tissue showing normal, hypodermal, fat, muscle and blood cells. × 300.

FIG. 6. Photomicrograph of army worm tissue showing disintegration of nuclei and cells with liberation of polyhedra. × 300.

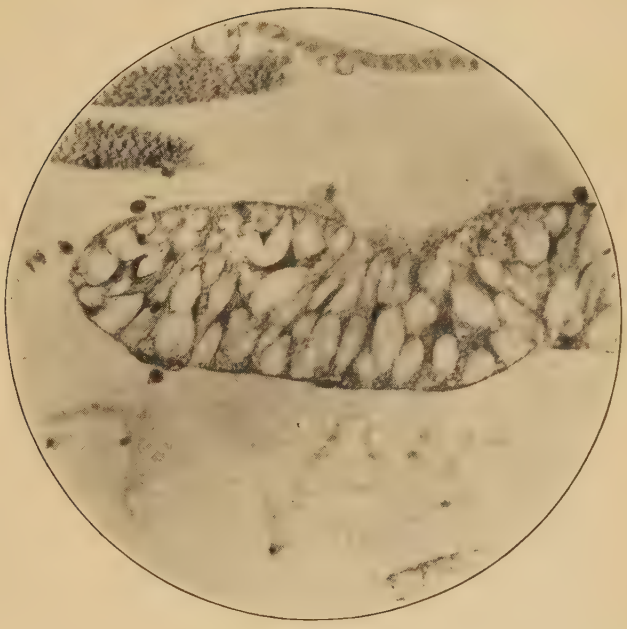

FIG. 5.

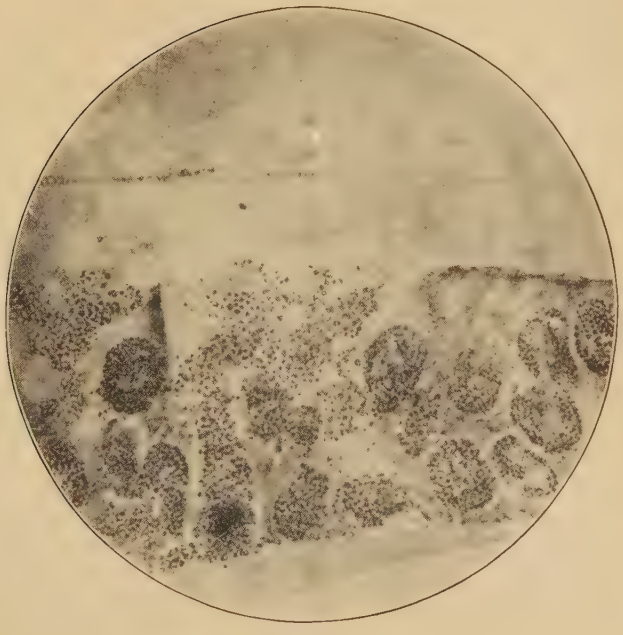

FIG. 6.

With the compliments of the Author.

THE AUSTRALIAN ANTS OF THE GENUS APHAENOGASTER, MAYR.[1]

By WILLIAM MORTON WHEELER.

(Communicated by Arthur M. Lea.)

[*From "Transactions of the Royal Society of South Australia," vol. xl., 1916.*]

The Australian Ants of the Genus Aphaenogaster, Mayr.[1]

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[Read July 13, 1916.]

Plates XXI. and XXII.

In 1858 Frederick Smith described from Melbourne, Victoria, under the name of *Myrmica (Monomorium) longiceps*, a very common and widely-distributed Australian ant, which was later referred by Mayr to the genus *Aphaenogaster*. It was subsequently placed, in the subgenus *Ischnomyrmex*, Mayr, and recently changed to *Deromyrma* by Forel, because the type of *Ischnomyrmex (longipes*, F. Smith) proved to be a *Pheidole*. Mayr in 1876 described the male and female of what he believed to be *A. longiceps*, Sm., from specimens taken in Queensland and New South Wales. Although Smith's description is sufficiently clear to indicate the modern generic allocation of his species, it was far from satisfactory for specific identification, and confusion at once resulted when Forel, in 1902, distinguished two Australian forms of *Aphaenogaster*, one from Adelaide, South Australia, which he referred to Smith's *longiceps*, and another from Victoria and New South Wales, which he described as a new subspecies, *ruginota*. For many years Forel and Emery believed that there were two forms of *Aphaenogaster* in Australia, the typical *longiceps* and Forel's subspecies *ruginota;* but as Smith's and Mayr's descriptions might apply to either, Emery in 1913 sent specimens to Mr. Meade-Waldo, who compared them with Smith's type, which is still in the British Museum. From this comparison Emery concluded that the Queensland form must be the true *longiceps* and the more southern form the subspecies *ruginota*. He gave figures of the males of what he took to be the two forms, but the differences between them are insignificant. In 1915 Forel elevated his *ruginota* to specific rank, and pointed out the differences that separate it in all three phases from what he regarded as the true *longiceps*. Not knowing which of the

(1) Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University. No. 116.

two had been described by Smith under this name, he proposed the name *pythia* for his own *longiceps*, in case *ruginota* should prove to be identical with Smith's type.

A study of a large number of specimens of *Aphaenogaster* collected during 1915 by myself in many localities in New South Wales and Queensland, and of many others recently loaned me for study by the Museum of South Australia, from Victoria, South and Western Australia, enables me to settle the matter under discussion. It happens that there are not only two, but *three* distinct, though superficially very similar species of *Aphaenogaster* in Australia, and that all three have had a share in the confusion. One, an undescribed species, which I shall call *barbigula*, ranges over Western and South Australia and eastward to the western portions of Victoria and New South Wales. I feel certain that this is the form called *longiceps* by Forel, when he is referring to specimens from Adelaide, Victoria, and Western Australia. In fact, some of my specimens from Victoria are from the same lot as some of those cited by Forel (Sea Lake, collected by J. C. Goudie). Of the two other species, one, extremely common and widely-distributed throughout the coastal portions of Victoria and New South Wales and the dryer portions of Queensland, corresponds to Forel's *ruginota;* the other, Forel's *longiceps*, seems to be rare and local, and is known only from Queensland and northern New South Wales. Suspecting that Forel and Emery had not interpreted Smith's *longiceps* correctly, I forwarded specimens of all three species to my friend, Mr. Horace Donisthorpe, who kindly compared them very carefully with Smith's type. He writes me that the type is undoubtedly what Forel called *ruginota*, and not what he called *longiceps*. Hence *ruginota* becomes a synonym of *longiceps*, Smith, and the rarer Queensland form. Forel's *longiceps*, which was unknown to Smith, must take the name *pythia*, Forel. That both of Emery's forms were *longiceps* is proved by his figures of the males, since the male *pythia* is quite different. Mayr probably confused both species. At any rate, his description will apply to the male and female of either, but as he introduced no new names his intepretation is now a matter of little moment. The female of *longiceps* had been previously described by Smith under the name of *Atta antipodum*.

There is some doubt concerning the subgeneric position of the Australian *Aphaenogasters*. Forel placed *longiceps* in the subgenus *Ischnomyrmex* because the male and female have only one cubital cell in the fore wing. When the type of *Ischnomyrmex* proved to be a *Pheidole*, he changed the name of the subgenus to *Deromyrma* and designated *A*

swammerdami, Forel, of Madagascar, as its type. This form and several other paleotropical and neotropical species have the head in the worker and female constricted behind to form a narrow neck, whereas another series, also with a single cubital cell in the wings (*cockerelli* and *albisetosa* of North America, *sagei* of the Himalayas, and *longiceps*), do not have the head narrowly constricted behind. Forel preferred to retain these species in the subgenus *Deromyrma*, because he attributed more value to the wing venation than to the shape of the head (Rev. Zool. Afr., 2, 1913, p. 350). Viehmeyer continued the subdivision of the genus *Aphaenogaster* by separating out the Papuan species *dromedarius*, *loriae*, and *quadrispina*, as a distinct subgenus, *Planimyrma* (Zool. Jahrb. Abth. f. Syst., 37, 1914). More recently Emery has carried the subdivision considerably further. He regards the Mediterranean species of the *testaceopilosa* group as constituting the subgenus *Aphaenogaster sens. str.* (with *sardoa*, Mayr, as the type). These forms have small females, with narrow thorax, which seem never to bear wings. The large series of circumpolar species allied to *subterranea*, Latreille, with large, winged females and two cubital cells, Emery places in a new subgenus, *Attomyrma*. The North American species, *cockerelli* and *albisetosa*, he assigns to another subgenus, *Novomessor*. Although the males and females of the Australian species and the Himalayan *sagei* have only one cubital cell, he prefers to place them in *Attomyrma* rather than in *Deromyrma*. While I agree that the Australian species should be removed from the subgenus *Deromyrma*, I do not believe that they should be assigned to *Attomyrma*. The three species form a very compact group, characterized not only by the presence of only one cubital cell, but also by their geographical isolation and the size of the female, which is much larger in proportion to the worker than in any of the other species of *Aphaenogaster*. They may, therefore, properly constitute a distinct subgenus, for which I propose the name *Nystalomyrma*, subgen. nov., with *Myrmica longiceps*, Smith, as the type. This leaves only the Himalayan *sagei* without a definite position. It may be placed in *Attomyrma*, as Emery suggests, especially as the female is only slightly larger than the largest worker forms.

It seems necessary to dwell at length on the taxonomic matters, because the three species of *Aphaenogaster*, and particularly *longiceps*, are among the commonest or most conspicuous ants in the *Eucalyptus* forests, and therefore familiar to all Australian entomologists. The species of *Nystalomyrma* are insectivorous, like most other species of *Aphaenogaster*, and live by preference in sand or sandy soil,

usually in moderately shady spots, where each colony makes numerous scattered or contiguous craters, often several inches in diameter, with very large entrance galleries, descending perpendicularly and deeply into the ground. These nests are often around the roots of trees, more rarely under prostrate logs or large stones. *Longiceps* and *pythia*, and doubtless also *barbigula*, which I have not seen alive, are nocturnal, so that although their earthworks are conspicuous objects in the "bush," they are quite deserted by the ants during the day. The colonies seem to be rather populous, but the individual workers are very timid. It is certainly astonishing that such small, slender insects should be able to build such extensive nests. At Koah, in Northern Queensland, I visited a piece of dry forest in which whole acres of the soil were covered with the craters of *longiceps*. These were larger and more compact than those seen in sandy localities in Queensland and New South Wales, and had very smooth, funnel-like entrances. At first I believed the nests at Koah to be the work of a distinct species, but the ants proved to be indistinguishable from typical *longiceps* in the other localities, so that the differences in the nests were probably due to differences in the soil. At Salisbury Court, near Uralla, New South Wales, while camping in the woods with Mr. W. W. Froggatt and his son, I was able to watch the workers of *longiceps* during the night, while they were busily bringing out their pellets of sand and earth and depositing them on the craters. The workers of *barbigula* have a true "psammophore" of long hairs on the lower-surface of the head, like many desert ants of various genera (*Pogonomyrmex*, *Cratomyrmex*, *Messor*, *Holcomyrmex*, *Myrmecocystus*, *Cataglyphis*, *Melophorus*, etc.), and therefore probably use this organ as a basket in which to carry out the moist sand-pellets. A note on the label in one bottle of this species received from the Museum of South Australia refers to its "nesting in sand." The following descriptions and figures will facilitate the identification of the Australian species of *Aphaenogaster*.

Aphaenogaster (Nystalomyrma) longiceps, F. Smith.

Pl. xxi., figs. 1-3; pl. xxii., figs. 1-4.

♀ *Myrmica (Monomorium) longiceps*, F. Smith: Cat. Hymen., Brit. Mus., 6, 1856, p. 128, ~~female~~.

Atta antipodum, F. Smith: *ibid.*, p. 166, female.

Myrmica longiceps, Lowne: Entomolgist, 2, 1865, p. 334.

Aphaenogaster longiceps, Mayr: Journ. Mus. Godeff., 12, 1876, p. 43, male, female (in part); Verh.: Zool. bot. Ges. Wien., 36, 1886, p. 359; Dalla Torre: Cat. Hymen., 7, 1893, p. 103.

Aphaenogaster(?) *antipodum*, Mayr: *ibid.*, p. 360, female.

Aphaenogaster antipodum, Dalla Torre: Cat. Hymen., 7, 1893, p. 98, female; Froggatt: Agric. Gaz. N.S.W., 1905, p. 21, female.

Stenamma longiceps, Froggatt: *ibid.*, p. 17.

Stenamma (Ischnomyrmex) longiceps, race *ruginota*, Forel: Rev. Suisse Zool., 10, 1902, p. 440, ~~two females~~. ☿ ♀

Aphaenogaster longiceps, subsp. *ruginota*, Emery: Boll. Lab. Zool. Gen. Agrar. Portici, 8, 1914, p. 181, fig. 1*b*, male.

Aphaenogaster longiceps, Emery: *ibid.*, p. 181, fig. 1*a*, male. •

Aphaenogaster (Deromyrma) ruginota, Forel: Ark. Zool., 9, 1915, p. 75, ~~two females~~ and male. ☿ ♀

Aphaenogaster (Attomyrma) longiceps, Emery: Rend. R. Acad. Sc. Ist. Bologna, 1915, p. 71.

Worker.—Length, 5-7 mm.

Head about one and one-quarter times as long as broad, as broad in front as behind, with feebly convex sides, rounded posterior corners and a pronounced, reflected occipital margin. Eyes rather small, convex at the middle of the sides of the head. Mandibles long, with rather straight external borders, their apical borders irregularly denticulate, with three larger teeth at the tip. Clypeus moderately convex, its anterior border broadly rounded and entire. Frontal carinae subparallel; frontal area large, triangular; frontal groove indistinct. Antennae slender; scapes extending about one-fourth their length beyond the occipital border of the head, their tips distinctly incrassated; funiculi with distinct 4-jointed club, and all the joints more than twice as long as broad. Thorax rather long and slender, pronotum slightly flattened above, rising posteriorly to the mesonotum, which slopes rapidly backward and is slightly concave anteriorly in profile, marginate on each side above and along its inferior border. Mesoëpinotal constriction abrupt and rather deep. Epinotum as high as long, its base horizontal and straight, forming a right-angle with the shorter declivity; the spines somewhat curved at base, slender and acute, less than half as long as the declivity, nearly as long as their distance apart at the base and directed backward and slightly outward. Petiole with a slender peduncle shorter than the node, which is rather high and rounded above, its anterior slope rising abruptly and perpendicularly from the peduncle. Seen from above, the node is longer than broad. Postpetiole a little higher than the petiolar node and somewhat broader. Legs long and slender; spurs of the hind tibiae very small.

Shining; mandibles subopaque, coarsely striated; clypeus and head above smooth and shining, longitudinally rugose

between the frontal carinae and eyes, the rugae diverging behind. Cheeks with coarse, elongate punctures. Mesonotum and epinotum subopaque and rugose-punctate, the rugae irregular on the sides and often transverse on the base of the epinotum; pronotum and declivity of epinotum smooth and shining, as are also the petiole, postpetiole, gaster, and legs. Antennal scapes and legs with sparse piligerous punctures.

Body, including the antennae and legs, covered with rather abundant, erect, coarse, yellowish hairs; those on the scapes and tibiae standing off at an angle of about 30° to 45°.

Yellowish-brown to piceous or castaneous-brown; appendages paler; first gastric segment in pale specimens often darker behind; mandibular teeth black.

Female.—Length, 10·5-12 mm.; wings, 13-14 mm.

Head rather small, scarcely longer than broad, subrectangular, very slightly broader behind than in front. Antennal scapes reaching about one-fourth their length beyond the posterior border of the head. Thorax large; mesonotum overarching the small pronotum in front, flattened behind; seen from above, distinctly longer than broad; scutellum longitudinally impressed in the middle; base of epinotum sloping, longer than the declivity, the spines long, blunt, directed upward, outward, and backward. Petiolar node compressed anteroposteriorly, its upper border feebly impressed in the middle; postpetiole short, broader than long. Gaster large. Wings with large discal cell and only one cubital cell.

Sculpture resembling that of the worker, but the whole upper-surface of head and cheeks longitudinally rugose, except a small median occipital area which is shining and coarsely punctate, and the clypeus, which is transversely rugulose on the sides. Thorax, including the mesopleurae, smooth and shining; epinotum sharply rugose, the rugae on the base transverse in front, arcuate behind, on the sides irregular above, longitudinal below and extending forward on to the mesosterna.

Pilosity like that of the worker.

Colour darker, castaneous; legs, usually including the coxae, yellowish; wings distinctly and uniformly infuscated throughout, radial vein and pterostigma dark-brown, remaining veins paler.

Male.—Length, 5-6 mm.; wings, 6-6·5 mm.

Head, excluding the eyes, distinctly longer than broad, convex behind and above, not broader behind than in front, its occipital border with a pronounced, strongly-reflected margin. Cheeks very short; eyes large and convex,

Mandibles narrow, with two or three teeth. Clypeus convex, with rounded entire anterior border. Antennal scapes slender, somewhat shorter than the head; funiculi with joints gradually increasing in length distally, but without distinct club; first joint slightly swollen. Thorax large; mesonotum, seen from above, as long as broad, very convex, especially in front, where it strongly overarches the very small pronotum. Mesosterna and mesopleurae large and very convex. Epinotum narrow, prolonged backward, its base rapidly sloping and more concave anteriorly, its posterior portion somewhat higher, subnodiform, and with very short declivity. Petiolar and postpetiolar nodes low and rounded, the latter longer than broad and somewhat broader than the former. Legs long and very slender. Venation of wings as in the female.

Pilosity and sculpture much as in the worker, but the hairs somewhat finer and the head much less rugose in front, the mesopleurae and upper-surface of the epinotum smooth and shining and the mandibles shining and sparsely punctate.

Colour as in the female, but the head darker, the mandibles yellow, and the wings and pterostigma somewhat paler. ♂

Hab.—Victoria: Melbourne (type locality); Yarra district (W. W. Froggatt); Swan River (locality of female, *Atta antipodum*, cited by F. Smith). New South Wales: Jenolan Caves (J. C. Wiburd); Port Hacking (W. B. Gurney); National Park, near Sydney, Sutherland, Leura, Katoomba, Hornsby, Manly, Sandringham, Bulli Pass, Gosford, and Uralla (Wheeler); Fitzroy Falls (R. J. Tillyard); Sydney (A. M. Lea); Sydney and Katoomba (F. Silvestri); Shoalhaven district (W. W. Froggatt); Dorrigo (W. Heron). Queensland: Mount Tambourine and Colosseum (E. Mjöberg); Townsville (F. P. Dodd); Brisbane and Koah (Wheeler); Bribie Island (Wheeler and H. Hacker).

Although series of specimens from different localities vary more or less in average size, in colour, sculpture, and the length and shape of the epinotal spines, it seems inadvisable on the basis of the material examined to confer names on the varieties of this species.

Aphaenogaster (Nystalomyrma) pythia, Forel.

Pl. xxi., figs. 4-6; pl. xxii., figs. 5-8.

Aphaenogaster longiceps, Mayr.: Journ. Mus. Godeff., 12, 1876, p. 43, female, male (in part).

Aphaenogaster (Deromyrma) longiceps, Forel: Ark. Zool., 9, 1915, p. 76, ~~two females~~ and male. ♀♀

Aphaenogaster (Deromyrma) pythia, Forel: *ibid.*, p. 76, two females and male.

Worker.—Length, 4-5·5 mm.

Averaging smaller than *longiceps*. Head scarcely longer than broad, distinctly broader behind than in front, with less-rounded posterior corners than in *longiceps*, and with less-constricted, though distinctly marginate, posterior border. Eyes distinctly less convex, antennae shorter, though the scapes surpass the occipital border of the head by nearly one-fourth their length; funicular joints shorter. Pronotum and base of epinotum more convex and rounded above in profile; mesoëpinotal constriction shorter. Epinotal spines shorter, much further apart at their base than long, and directed more upward. Petiolar node rising less abruptly from the peduncle. Legs shorter and stouter, gaster perhaps a little larger than in *longiceps*.

Smoother and more shining; mandibles subopaque and shining; the rugae between the frontal carinae and eyes feebler; epinotum smooth and shining above; sides of mesonotum and epinotum much more finely rugulose-punctate, so that their surfaces are also more shining.

Hairs finer and paler and a little more oblique on the legs and antennal scapes.

Colour usually paler and more yellowish than in *longiceps*.

Female.—Length, 9·5-11 mm.; wings, 12·5-13 mm.

Smaller than the female of *longiceps*, with the posterior corners of the head more pronounced and less rounded, the eyes somewhat less convex, the antennae, thorax, and legs shorter, and the epinotal spines smaller and acute. Venation as in *longiceps*.

Sculpture much as in *longiceps*, but the head more subopaque and more finely rugose. Gaster and upper-surface of thorax very smooth and shining.

Pilosity as in the worker.

Colour distinctly paler than that of the female *longiceps*, wings less deeply infuscated, yellowish-hyaline, with the radial vein and pterostigma dark-brown. Mesonotum with three large longitudinal brown blotches, gaster behind the first segment brownish-yellow, as are also the legs, including the coxae.

Male.—Length, 4-4·5 mm.

Smaller than the male of *longiceps*, the head and antennae shorter, the former scarcely longer than broad, excluding the eyes; thorax much shorter and broader, the

pronotum and scutellum seen together from above scarcely longer than broad. In profile the scutellum is more convex and projecting, the anterior portion of the base of the epinotum descends more abruptly, and the nodiform posterior enlargement is more pronounced in profile, but less pronounced when seen from above. The nodes of the petiole and postpetiole are much lower than in *longiceps*.

Sculpture, colour, and pilosity much as in that species.

Hab.—Queensland: Herberton (type locality) and Cedar Creek (E. Mjöberg); Gayndah; Peak Downs; Rockhampton; Kuranda and Enoggera (Wheeler). New South Wales: Dorrigo (W. Heron).

Aphaenogaster (Nystalomyrma) barbigula, sp. nov.

Pl. xxi., figs. 7 to 9; pl. xxii., fig. 9.

Stenamma (Ischnomyrmex) longiceps, Forel: Rev. Suisse Zool., 10, 1902, p. 439. ~~female;~~ Fauna S.W. Aust., Hamb. Exped., 1, 1907, p. 284, ~~two females~~ and male.

Aphaenogaster (Deromyrma) longiceps, Forel: Bull. Soc. Vaud. Sc. Nat., 49, 1913, p. 187, ~~female.~~

Worker.—Length, 4·5-5·5 mm.

Head regularly-elliptical, about one and one-fifth times as long as broad, not broader behind than in front, with convex sides, rounded behind the eyes, and without posterior corners. Occipital border feebly reflexed. Eyes moderately convex. Mandibles irregularly denticulate, with three larger apical teeth. Clypeus, frontal carinae, and frontal area much as in *longiceps;* frontal groove indistinct. Antennae rather long, scapes incrassated distally, extending less than one-fourth their length beyond the posterior border of the head, funiculi distinctly 4-jointed, all the joints shorter than in *longiceps*. Pronotum and base of epinotum rounded and convex in profile; mesoëpinotal constriction long and pronounced, epinotal spines reduced to small, rather acute, suberect teeth. Petiolar node rounded, lower than in *longiceps* or *pythia*. Postpetiole scarcely longer than broad, decidedly broader than the petiole, in profile with abrupt posterior slope. Legs rather slender; posterior tibiae with small spurs.

Shining; mandibles subopaque, longitudinally striate; clypeus feebly and transversely rugulose; head very smooth and shining above and behind, sharply, longitudinally rugose between the frontal carinae and eyes; cheeks only with several small, scattered, piligerous punctures. Thorax smooth and shining, with the sides of the mesonotum and epinotum punctate-rugose, the rugae being somewhat longitudinal on

the former; remainder of body smooth and shining, with small, scattered piligerous punctures.

Hairs as in *longiceps* and *pythia*, except that they are very long on the gula, forming a well-developed psammophore; on the scapes and legs they are more oblique than in *longiceps* and more as in *pythia*.

Colour variable and like that of *longiceps*.

Female.—Length, 13 mm.; wings, 13·5 mm.

Similar to the females of the two preceding species. Head subrectangular, a little broader behind than in front, with rounded posterior corners. Antennal scapes extending only a short distance beyond the posterior border of the head. Thorax rather long; base of epinotum long, its spines acute, shorter than in *longiceps* and directed downward and backward. Scutellum and petiolar node without median impression. Venation of the wings as in the preceding species.

Smooth and shining; mandibles subopaque, finely striate; clypeus transversely rugulose; head finely, longitudinally rugose; rugosity on the base of the epinotum above fine, indistinct and transverse, more distinct and longitudinal on the sides.

Hairs similar to those of the worker but rather short, except on the gula, where they form a psammophore, as in the worker.

Colour uniformly yellowish-ferruginous, with slightly paler legs. Wings yellowish-hyaline, as pale as in *pythia*, with dark-brown radial vein and pterostigma; remaining veins resin-coloured.

Hab.—South Australia: Adelaide (type locality) (A. M. Lea and Rothney); Meningie (L. H. Mincham); Gawler (A. M. Lea); Karoonda to Peebinga (G. E. H. Wright). Western Australia: Dongarra; Gooseberry Hill; Wallaby Island; Beverley (F. H. Duboulay). Victoria: Sea Lake (J. C. Goudie). New South Wales: Yanco (W. W. Froggatt).

This species, described from numerous workers from many of the localities cited above and a single female taken by Mr. G. E. H. Wright between Karoonda and Peebinga, is readily distinguished from *longiceps* and *pythia* by the conspicuous psammophore of the worker and female, by the peculiar shape of the head and very short epinotal spines of the worker, and by the downwardly-directed epinotal spines of the female. The male seems to have been seen by Forel, but was not described, as it was referred to *longiceps*. When again taken it will probably be found to differ as much from the males of *longiceps* and *pythia* as the worker and female differ from the corresponding phases of these species.

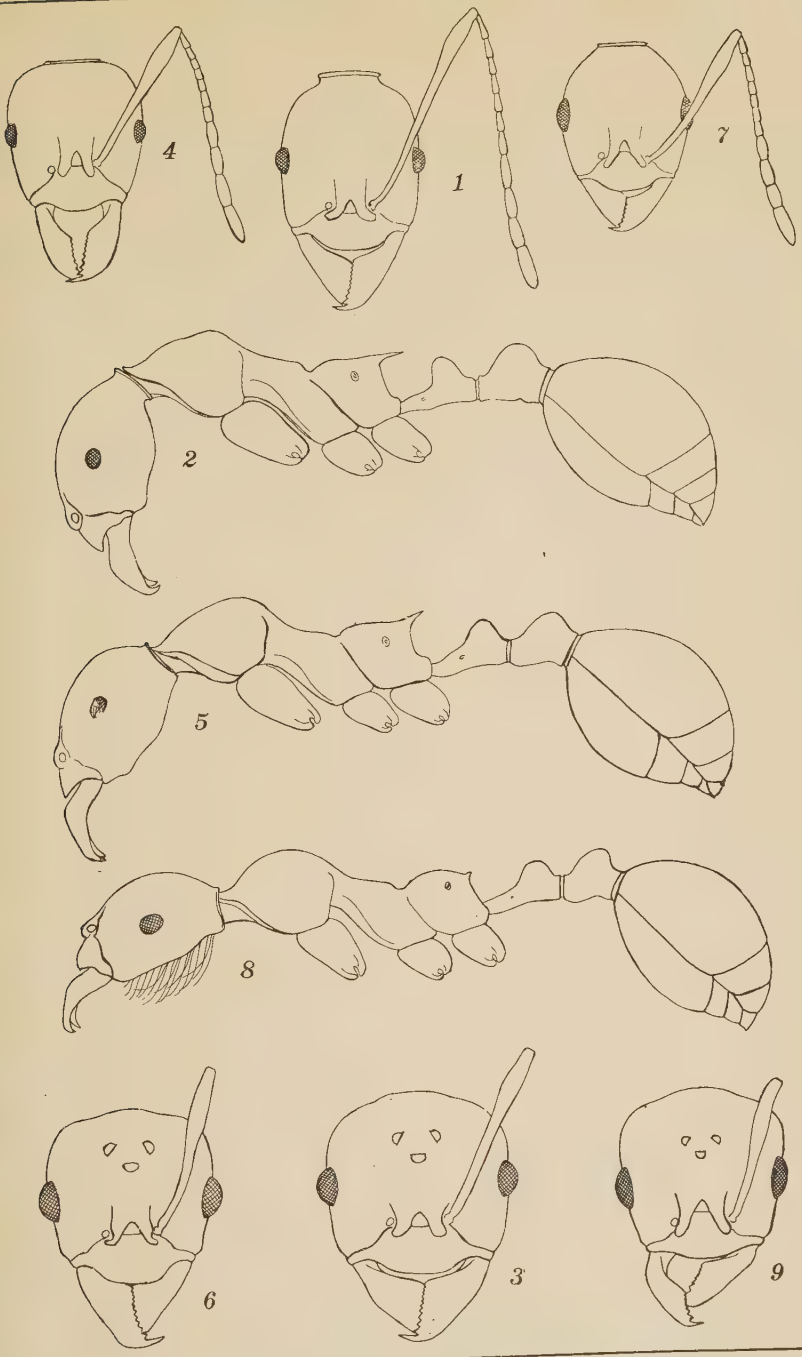
DESCRIPTION OF PLATES.

Plate XXI.

Fig. 1. *Aphaenogaster (Nystalomyrma) longiceps*, F. Smith. Head of worker, dorsal view.
,, 2. Worker, body in profile.
,, 3. Head of female, dorsal view.
,, 4. *Aphaenogaster (Nystalomyrma) pythia*, Forel. Head of worker, dorsal view.
,, 5. Worker, body in profile.
,, 6. Head of female, dorsal view.
,, 7. *Aphaenogaster (Nystalomyrma) barbigula*, n. sp. Head of worker, dorsal view.
,, 8. Worker, body in profile.
,, 9. Head of female, dorsal view.

Plate XXII.

Fig. 1. *Aphaenogaster (Nystalomyrma) longiceps*, F. Smith. Thorax, petiole, and postpetiole of female in profile.
,, 2. Same of male.
,, 3. Thorax of male, dorsal view.
,, 4. Head of male, dorsal view.
,, 5. *Aphaenogaster (Nystalomyrma) pythia*, Forel. Thorax, petiole, and postpetiole of female in profile.
,, 6. Same of male.
,, 7. Thorax of male, dorsal view.
,, 8. Head of male, dorsal view.
,, 9. *Aphaenogaster (Nystalomyrma) barbigula*, n. sp. Thorax, petiole, and postpetiole of female in profile.



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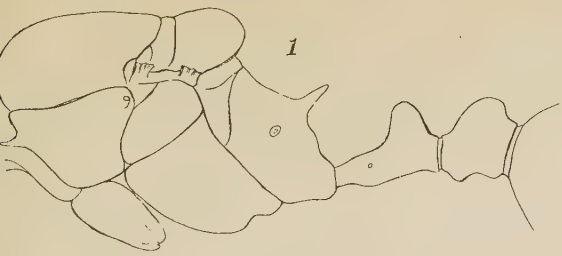

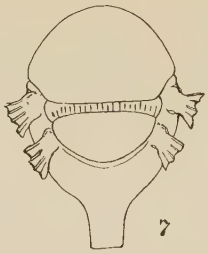

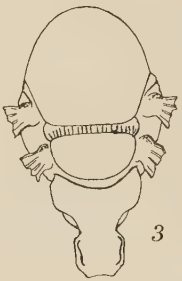

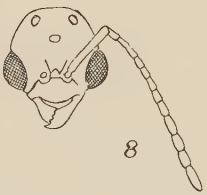

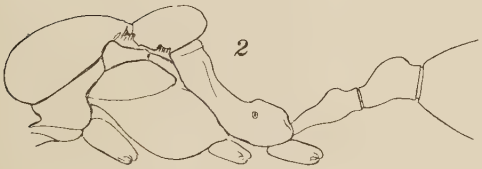

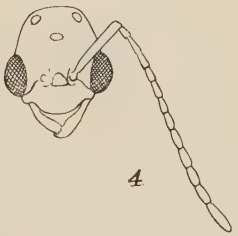

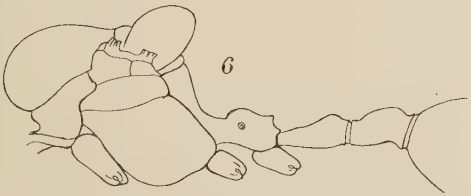

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